



ANNA UNIVERSITY, CHENNAI
UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: Alagappa College of Technology

Department: Biotechnology

Programme: B.Tech. Food Technology

Regulations: 2023 (Revised 2024), with effect from the AY 2024 – 25 to all the students of UG Programme.

OVERVIEW OF CREDITS

Sem	PCC	PEC	ESC	HSMC	ETC	OEC	SDC	UC	SLC	Total
I	0	0	3	14	0	0	4	1	0	22
II	0	0	7	11	0	0	3	1	0	22
III	13	0	5	4	0	0	0	3	0	25
IV	15	0	0	4	0	0	2	3	0	24
V	11	3	0	0	3	0	3	0	1	21
VI	0	12	0	0	3	3	3	3	0	24
VII	14	3	0	0	0	3	3	0	0	23
VIII	0	0	0	0	0	0	8	0	0	8
Total	53	18	15	33	6	6	26	11	1	169
% of Category	31.3	10.7	8.8	19.5	3.6	3.6	15.4	6.5	0.6	100

CATEGORY OF COURSES

PCC – Professional Core Course

PEC – Professional Elective Course

ETC – Emerging Technology Course

OEC – Open Elective Course

SLC – Self Learning Course

ESC – Engineering Science Course

HSMC – Humanities Science and Management Course

SDC – Skill Development Course

UC – University Course

****For Honours & Minor Degree, please refer the Regulations 2023 (Revised 2024).***

SEMESTER – I

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	EN23C01	Foundation English	LIT	2-0-2	4	3	HSMC
2	MA23C01	Matrices and Calculus	T	3-1-0	4	4	HSMC
3	PH23C01	Engineering Physics	LIT	3-0-2	5	4	HSMC
4	FT23101	Principles of Thermodynamics	T	3-0-0	3	3	HSMC
5	ME23C01	Engineering Drawing and 3D Modelling	LIT	2-0-4	6	4	SDC
6	EE23C03	Basics of Electrical and Electronics Engineering	LIT	2-0-2	4	3	ESC
7	UC23H01	தமிழர் மரபு / Heritage of Tamils	T	1-0-0	1	1	UC
8	-	NCC/NSS/NSO/YRC	-	0-0-2	2	-	UC
9	-	Audit Course – I	-	-	-	-	UC
TOTAL CREDITS						22	

SEMESTER – II

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	MA23C02	Ordinary Differential Equations and Transform Techniques	T	3-1-0	4	4	HSMC
2	EN23C02	Professional Communication	LIT	2-0-2	4	3	HSMC
3	CY23C01	Engineering Chemistry	LIT	3-0-2	5	4	HSMC
4	FT23201	Post-Harvest Technology	T	3-0-0	3	3	ESC
5	ME23C04	Makerspace	LIT	1-0-4	5	3	SDC
6	CS23C02	Computer Programming in Python	LIT	3-0-2	5	4	ESC
7	UC23H02	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	T	1-0-0	1	1	UC
TOTAL CREDITS						22	

SEMESTER – III							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	MA23C06	Partial Differential Equations and Complex Functions	T	3-1-0	4	4	HSMC
3	FT23301	Food Microbiology	LIT	3-0-4	7	5	PCC
4	FT23302	Biochemistry and Human Nutrition	LIT	3-0-4	7	5	PCC
5	FT23303	Stoichiometry in Food Industries	T	2-1-0	3	3	PCC
6	FT23304	Fluid Mechanics and Mechanical Operations	LIT	3-0-4	7	5	ESC
7	FT23U02	Perspectives of Sustainable Development – Food Technology	T	3-0-0	3	3	UC
8.	-	Audit Course – II	-	-	-	-	UC
TOTAL CREDITS						25	

SEMESTER – IV							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	MA23C05	Probability and Statistics	T	3-1-0	4	4	HSMC
2	FT23401	Heat and Mass Transfer in Food Processes	LIT	3-0-4	7	5	PCC
3	FT23402	Food Processing and Preservation	LIT	3-0-4	7	5	PCC
4	FT23403	Food Chemistry	LIT	3-0-4	7	5	PCC
5	UC23U01	Universal Human Values	LIT	1-0-2	3	2	UC
6	FT23U01	Standards - Food Technology	T	1-0-0	1	1	UC
7	FT23404	Sustainable Food Product Development	T	2-0-0	2	2	SDC
TOTAL CREDITS						24	

SEMESTER – V (PREFERENCE FOR FOREIGN EXCHANGE)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	FT23501	Food Refrigeration and Cold Chain	T	3-0-0	3	3	PCC
2	FT23502	Food Analysis	LIT	3-0-4	7	5	PCC
3	FT23503	Food Process Engineering	T	3-0-0	3	3	PCC
4	-	Professional Elective I	T	3-0-0	3	3	PEC
5	FT23504	Food Informatics	T	3-0-0	3	3	ETC
6	FT23505	Project Management and Finance	T	2-0-0	2	2	SDC
7	-	Industry Oriented Course I	T	1-0-0	1	1	SDC
8	FT23L01	Self-Learning Course# (Minimum Duration 15 h)	T	0-0-0	0	1	SLC

TOTAL CREDITS 21

COURSES FOR HONOURS DEGREE

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	FT23D01	Capstone Design Project – Level I	CDP	0-0-12	12	6	SDC

(OR)

1.		Honours Elective – I	T	3-0-0	3	3	PEC
2.		Honours Elective – II	T	3-0-0	3	3	PEC

COURSES FOR MINOR DEGREE

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
1.		Minor Elective – I	T	3-0-0	3	3	PEC
2.		Minor Elective – II	T	3-0-0	3	3	PEC

SEMESTER – VI (PREFERENCE FOR FOREIGN EXCHANGE)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	FT23601	Foodomics	T	3-0-0	3	3	ETC
2	FT23602	Food Business Management and Entrepreneurship	T	3-0-0	3	3	UC
3	FT23603	Food Plant Layout and Design	T	2-0-0	2	2	SDC
4	-	Industry Oriented Course II	T	1-0-0	1	1	SDC
5	-	Open Elective - I	T	3-0-0	3	3	OE
6	-	Professional Elective II	T	3-0-0	3	3	PEC
7	-	Professional Elective III	T	3-0-0	3	3	PEC
8	-	Professional Elective IV	T	3-0-0	3	3	PEC
9	-	Professional Elective V	T	3-0-0	3	3	PEC
TOTAL CREDITS						24	

COURSES FOR HONOURS DEGREE

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	FTD2302	Capstone Design Project – Level II	CDP	0-0-12	12	6	SDC

(OR)

1.	-	Honours Elective – III	T	3-0-0	3	3	PEC
2.	-	Honours Elective – IV	T	3-0-0	3	3	PEC

COURSES FOR MINOR DEGREE

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	-	Minor Elective – III	T	3-0-0	3	3	PEC
2.	-	Minor Elective – IV	T	3-0-0	3	3	PEC

SEMESTER – VII							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	FT23701	Functional Foods and Nutraceuticals	T	3-0-0	3	3	PCC
2	FT23702	Food Safety and Quality Management	T	3-0-0	3	3	PCC
3	FT23703	Food Packaging Technology	LIT	3-0-4	7	5	PCC
4	FT23704	Food Additives and Flavors	T	3-0-0	0	3	PCC
5	-	Professional Elective VI	T	3-0-0	3	3	PEC
6	-	Open Elective - II	T	3-0-0	3	3	OE
7	-	Industry Oriented Course III	T	1-0-0	1	1	SDC
8	FT23706	Internship	IPW	0-0-2	2	2	SDC
TOTAL CREDITS						23	
COURSES FOR HONOURS DEGREE							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	FT23D03	Capstone Design Project – Level III	CDP	0-0-12	12	6	SDC
(OR)							
1.	-	Honours Elective – V	T	3-0-0	3	3	PEC
2.	-	Honours Elective – VI	T	3-0-0	3	3	PEC
COURSES FOR MINOR DEGREE							
S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	-	Minor Elective – V	T	3-0-0	3	3	PEC
2.	-	Minor Elective – VI	T	3-0-0	3	3	PEC

SEMESTER – VIII

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	FT23801	Project Work / Internship cum Project Work	IPW	0-0-16	16	8	SDC
Total Credits						8	

PROFESSIONAL ELECTIVE COURSE (PEC) VERTICALS – Regulation 2023**VERTICAL I – DAIRY AND BEVERAGE TECHNOLOGY**

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23001	Dairy Chemistry and Microbiology	T	3-0-0	3	3
2	FT23002	Value-added Dairy Products	T	3-0-0	3	3
3	FT23003	Quality and Safety Monitoring in Dairy Industry	T	3-0-0	3	3
4	FT23004	Precision Fermentation for Dairy Alternatives	T	3-0-0	3	3
5	FT23005	Cheese Technology	T	3-0-0	3	3
6	FT23006	Processing of Dairy Products	T	3-0-0	3	3
7	FT23007	Innovative Packaging of Dairy Products	T	3-0-0	3	3

VERTICAL II – MEAT, MARINE AND POULTRY TECGNOLOGY

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23008	Introduction to Meat, Marine and Poultry	T	3-0-0	3	3
2	FT23009	Meat and Poultry Processing	T	3-0-0	3	3
3	FT23010	Byproducts in Meat, Poultry and Fish Processing	T	3-0-0	3	3
4	FT23011	Preservation Technology of Eggs, Meat, Poultry and Seafood	T	3-0-0	3	3
5	FT23012	Marine Foods Processing	T	3-0-0	3	3
6	FT23013	Technology of Packing Meat and Marine Products	T	3-0-0	3	3
7	FT23014	Quality, Laws, and Regulations in Meat Industries	T	3-0-0	3	3

VERTICAL III – CEREALS, PULSES AND GRAIN TECHNOLOGY

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23015	Milling and Fractionation Technologies	T	3-0-0	3	3
2	FT23016	Technology of Malting and Brewing	T	3-0-0	3	3
3	FT23017	Processing of Cereals, Oilseeds and Pulses	T	3-0-0	3	3
4	FT23018	Byproducts Management	T	3-0-0	3	3
5	FT23019	Enrichment and Fortification of Cereals and Oils	T	3-0-0	3	3
6	FT23020	Fat and Oil Technology	T	3-0-0	3	3
7	FT23021	Quality, Laws, and Regulations in Grain Processing Industries	T	3-0-0	3	3

VERTICAL IV – FRUIT AND VEGETABLE TECHNOLOGY

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23022	Post-Harvest Technology of Fruits and Vegetables	T	3-0-0	3	3
2	FT23023	Technology of Fruit and Vegetable Processing	T	3-0-0	3	3
3	FT23024	Advances in Fruit and Vegetable Processing Technologies	T	3-0-0	3	3
4	FT23025	Fruits and Vegetables as Nutraceuticals	T	3-0-0	3	3
5	FT23026	Innovative Packaging of Fruit and Vegetables	T	3-0-0	3	3
6	FT23027	Fruit and Vegetable Industry Safety and Laws	T	3-0-0	3	3
7	FT23028	Fruit and Vegetable Storage	T	3-0-0	3	3

VERTICAL V – BAKING AND CONFECTIONERY TECHNOLOGY

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23029	Introduction to Baking and Bakery Products	T	3-0-0	3	3
2	FT23030	Flour Chemistry and Rheology	T	3-0-0	3	3
3	FT23031	Industrial Production of Bread, Bun, Cakes and Pastries	T	3-0-0	3	3
4	FT23032	Industrial Production of Cookies and Biscuits	T	3-0-0	3	3
5	FT23033	Laws and Regulations of Bakery and Confectionery Products	T	3-0-0	3	3
6	FT23034	Confectionery Products	T	3-0-0	3	3
7	FT23035	Packaging of Baking and Confectionery Products	T	3-0-0	3	3

VERTICAL VI – SPICES AND PLANTATION TECHNOLOGY

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23036	Processing and Storage of Spices and Plantation Crops	T	3-0-0	3	3
2	FT23037	Processing of Coffee	T	3-0-0	3	3
3	FT23038	Processing of Tea	T	3-0-0	3	3
4	FT23039	Processing of Cocoa and Chocolate	T	3-0-0	3	3
5	FT23040	Laws, Quality Standards and Regulations for Spice Processing and Products	T	3-0-0	3	3
6	FT23041	Blending and Value Addition	T	3-0-0	3	3
7	FT23042	Packaging of Spices and Plantation Products	T	3-0-0	3	3

VERTICAL VII – FOOD SAFETY MANAGEMENT SYSTEM

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23043	Introduction to Food Safety Analysis and Quality Risk Management	T	3-0-0	3	3
2	FT23044	HACCP in Food Processing and Preservation	T	3-0-0	3	3
3	FT23045	Food Product and Supply Chain Management	T	3-0-0	3	3
4	FT23046	Food Laws – Indian and International	T	3-0-0	3	3
5	FT23047	Food Safety in Hospitality Industry & GLP in Food Industries	T	3-0-0	3	3
6	FT23048	Food Analysis, Testing and Microbial Safety Analysis	T	3-0-0	3	3
7	FT23049	Food Quality Assurance and Quality Control	T	3-0-0	3	3

LIST OF EMERGING TECHNOLOGY COURSES (ETC)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23E01	Food Informatics	T	3-0-0	3	3
2	FT23E02	Foodomics	T	3-0-0	3	3
3	FT23E03	Artificial Intelligence and Machine Learning Fundamentals	LIT	2-0-2	4	3
4	FT23E04	IoT Concepts and Applications	LIT	2-0-2	4	3
5	FT23E05	Data Science Fundamentals	LIT	2-0-2	4	3
6	FT23E06	Augmented Reality /Virtual Reality	LIT	2-0-2	4	3

LIST OF SKILL DEVELOPMENT COURSES (SDC)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23S01	Professional Development	LIT	1-0-2	3	2
2	FT23S02	Sustainable Food Product Development	T	2-0-0	2	2
3	FT23S03	Project Management and Finance	T	2-0-0	2	2
4	FT23S04	Food Plant Layout and Design	T	2-0-0	2	2

LIST OF INDUSTRY ORIENTED COURSES (IOC)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1		Instant Noodles Technology	T	1-0-0	1	1
2		Waste Management in Food Industry	T	1-0-0	1	1
3		Digital Transformation in Food Industry	T	1-0-0	1	1

OPEN ELECTIVE TO OTHER DEPARTMENTS (OEC)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23901	Traditional Foods	T	3-0-0	3	3
2	FT23902	Food Adulterants	T	3-0-0	3	3

COURSES TO BE STUDIED BY B.Sc. LATERAL ENTRY STUDENTS

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23101	Principles of Thermodynamics	T	3-0-0	3	3
2	FT23201	Post-Harvest Technology	T	3-0-0	3	3

COURSES TO BE STUDIED BY DIPLOMA LATERAL ENTRY STUDENTS

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1	FT23101	Principles of Thermodynamics	T	3-0-0	3	3
2	FT23201	Post-Harvest Technology	T	3-0-0	3	3

COURSE OBJECTIVES:

- To develop students' foundational skills in reading, writing, grammar and vocabulary to enable them to understand and produce various forms of communication.
- To enhance students' proficiency in reading comprehension, narrative and comparative writing.
- To comprehend and analyse descriptive texts and visual images
- To articulate similarities and differences in oral and written forms.
- To improve students' proficiency in reading and writing formal letters and emails.

UNIT I BASICS OF COMMUNICATION**6**

Reading - Telephone message, bio-note; Writing – Personal profile; Grammar – Simple present tense, Present continuous tense, wh-questions, indirect questions; Vocabulary – Word formation (Prefix and Suffix).

LAB ACTIVITY:**6**

Listening – Telephone conversation; Speaking Self-introduction; Telephone conversation – Video conferencing etiquette

UNIT II NARRATION**6**

Reading – Comprehension strategies - Newspaper Report, An excerpt from an autobiography; Writing – Narrative Paragraph writing (Event, personal experience etc.); Grammar – Subject-verb agreement, Simple past, Past continuous Tenses; Vocabulary – One-word substitution

LAB ACTIVITY:**6**

Listening – Travel podcast; Speaking – Narrating and sharing personal experiences through a podcast

UNIT III DESCRIPTION**6**

Reading – A tourist brochure, Travel blogs, descriptive article/excerpt from literature, visual images; Writing –Descriptive Paragraph writing, Grammar – Future tense, Perfect tenses, Preposition; Vocabulary – Descriptive vocabulary

LAB ACTIVITY:**6**

Listening – Railway / Airport Announcements, Travel Vlogs; Speaking – Describing a place or picture description

UNIT IV COMPARE AND CONTRAST**6**

Reading – Reading and comparing different product specifications - Writing – Compare and Contrast Essay, Coherence and cohesion; Grammar – Degrees of Comparison; Vocabulary – Transition words (relevant to compare and contrast)

LAB ACTIVITY: 6

Listening – Product reviews, Speaking – Product comparison based on product reviews - similarities and differences

UNIT V EXPRESSION OF VIEWS 6

Reading – Formal letters, Letters to Editor ; Writing – Letter writing/ Email writing (Enquiry / Permission, Letter to Editor); Grammar – Compound nouns, Vocabulary – Synonyms, Antonyms

LAB ACTIVITY: 6

Listening – Short speeches; Speaking – Making short presentations (JAM)

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment

Written assessments

Assignment

Lab assessment

Listening

Speaking

External Assessment

End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- Use appropriate grammar and vocabulary to read different types of text and converse appropriately.
- Write coherent and engaging descriptive and comparative essay writing.
- Comprehend and interpret different kinds of texts and audio visual materials
- Critically evaluate reviews and articulate similarities and differences
- Write formal letters and emails using appropriate language structure and format

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022
2. “English for Science & Technology - I” by Cambridge University Press, 2023

REFERENCES

1. “Interchange” by Jack C.Richards, Fifth Edition, Cambridge University Press, 2017.
2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.
3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019
4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		
CO3										√		√
CO4										√		
CO5										√		√

OBJECTIVES:

- To develop the use of matrix algebra techniques in solving practical problems.
- To familiarize the student with functions of several variables.
- To solve integrals by using Beta and Gamma functions.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals.
- To acquaint the students with the concepts of vector calculus which naturally arise in many engineering problems.

UNIT I MATRICES**9+3**

Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors- Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES**9+3**

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions – Jacobians -Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

UNIT III INTEGRAL CALCULUS**9+3**

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of single integrals by using Beta and Gamma functions..

UNIT IV MULTIPLE INTEGRALS**9+3**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals- Evaluation of double and triple integrals by using Beta and Gamma functions.

UNIT V VECTOR CALCULUS**9+3**

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems (without proofs)– Verification and applications in evaluating line, surface and volume integrals.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students wherever applicable from the content of the course.

General engineering applications / branch specific applications from the content of each units wherever possible will be introduced to students.

Suggested Laboratory based exercises / assignments / assessments :

Matrices

1. Finding eigenvalues and eigenvectors
2. Verification of Cayley-Hamilton theorem
3. Eigenvalues and Eigenvectors of similar matrices
4. Eigenvalues and Eigenvectors of a symmetric matrix
5. Finding the powers of a matrix
6. Quadratic forms

Functions of Several Variables

1. Plotting of curves and surfaces
2. Symbolic computation of partial and total derivatives of functions

Integral Calculus

1. Evaluation of beta and gamma functions
2. Computation of error function and its complement

Multiple Integrals

1. Plotting of 3D surfaces in Cartesian and Polar forms

Vector Calculus

1. Computation of Directional derivatives
2. Computation of normal and tangent to the given surface

OUTCOMES:

CO 1 :Use the matrix algebra methods for solving practical problems.

CO 2 :Use differential calculus ideas on several variable functions.

CO 3 :Apply different methods of integration in solving practical problems by using Beta and Gamma functions.

CO 4 :Apply multiple integral ideas in solving areas and volumes problems.

CO 5 :Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir ""Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, New Delhi, 2020.
3. James Stewart, Daniel K Clegg & Saleem Watson "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2023.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education 2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, 5th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

COURSE OBJECTIVES

- To familiarize with crystal structure, bonding and crystal growth.
- To impart knowledge on Mechanics of Materials.
- To impart knowledge of oscillations, sound and Thermal Physics
- To facilitate understanding of optics and its applications, different types of Lasers and fiber optics.
- To introduce the basics of Quantum Mechanics and its importance.

UNIT I CRYSTAL PHYSICS**9+6**

Crystal Bonding – Ionic – covalent – metallic and van der Waals's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czochralski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

1. Determination of Lattice parameters for crystal systems.
2. Crystal Growth – Slow Evaporation method
3. Crystal Growth Sol – Gel Method

UNIT II MECHANICS OF MATERIALS**9+6**

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders – Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

4. Non-uniform bending -Determination of Young's modulus of the material of the beam.
5. Uniform bending -Determination of Young's modulus of the material of the beam
6. Viscosity – Determination of Viscosity of liquids.

UNIT III OSCILLATIONS, SOUND AND THERMAL PHYSICS**9+6**

Simple harmonic motion - Torsional pendulum -- Damped oscillations –Shock Absorber -Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

7. Torsional pendulum-Determination of rigidity modulus of wire and moment of inertia of the disc
8. Melde's string experiment - Standing waves.
9. Ultrasonic interferometer – determination of sound velocity and liquids compressibility

UNIT IV OPTICS AND LASERS**9+6**

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer – Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers

— Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, CO₂ laser, Semiconductor laser - Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers.

10. Laser - Determination of the width of the groove of the compact disc using laser.
Laser Parameters
Determination of the wavelength of the laser using grating
11. Air wedge -Determination of the thickness of a thin sheet/wire
12. Optical fibre - Determination of Numerical Aperture and acceptance angle
-Determination of bending loss of fibre.
13. Michelson Interferometer (Demonstration)

UNIT V QUANTUM MECHANICS

9+6

Black body radiation (Qualitative) – Planck’s hypothesis – Einstein’s theory of Radiation - Matter waves– de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

14. Photoelectric effect – Determination of Planck’s constant.
15. Black Body Radiation (Demonstration)
16. Electron Microscope (Demonstration)

TOTAL: 75 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

- CO1:** Understand the significance of crystal structure and bonding. Learn to grow crystals.
- CO2:** Obtain knowledge on important mechanical and thermal properties of materials and determine them through experiments.
- CO3:** Conceptualize and visualize the oscillations and sound.
- CO4:** Grasp optical phenomenon and their applications in real life.
- CO5:** Appreciate and evaluate the quantum phenomenon.
- CO6** Develop skill set to solve engineering problems and design experiments.

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th Edition, 2015.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1		1							
CO2	3	2	1	1								
CO3	3	2	1	1								
CO4	3	2	1	1	1							
CO5	3	2	1	1	1							
CO6	3	2	1	2								

OBJECTIVES

Students will learn the PVT behavior of fluids, laws of thermodynamics, thermodynamic property relations, and their application to fluid flow, power generation, and refrigeration processes.

UNIT I BASIC CONCEPTS**7**

Scope of thermodynamics; Definition of system, control volume, state and path function, equilibrium, reversibility, energy, work, and heat. zeroth law; temperature scales PVT behavior of fluids; Mathematical representation of PVT behavior; Generalized compressibility factor correlation; Generalized equations of state.

UNIT II LAWS OF THERMODYNAMICS**10**

Joule's experiment, internal energy, first law, energy balance for closed systems, mass and energy balance for open systems Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume, Third law of thermodynamics, entropy from a microscopic point of view.

UNIT III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE**10**

Thermodynamic potentials – internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams

UNIT IV THERMODYNAMIC RELATIONS AND PHASE EQUILIBRIA**9**

Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, excess properties of mixtures. Criteria for equilibrium between phases in multi-component non-reacting systems in terms of chemical potential and fugacity, application of phase rule, vapor-liquid equilibrium, phase diagrams for homogeneous systems and systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.

UNIT V GAS MIXTURES AND PSYCHROMETRY**9**

Mole and Mass fraction, Dalton's and Amagat's Law. Properties of gas mixture – Molar mass, gas constant, density, change in internal energy, enthalpy, entropy, and Gibbs function Psychrometric properties, Psychrometric charts. Property calculations of air vapor mixtures by using chart and expressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO1 Understand the fundamental concepts of thermodynamics

CO2 Apply the second law and analyze the feasibility of systems/devices;

CO3 Understand the real gas behavior

CO4 Understand thermodynamic relations and phase equilibria

CO5 Understand the properties of gas mixtures and apply them to psychrometric processes

TEXTBOOKS

1. Nag P. K. Thermodynamics, 2005. 5th edition, Tata Mc Graw Hill, New Delhi. 2001.
2. Ethirajan Rathakrishnan. Fundamentals of Engineering Thermodynamics. (PHI).2010.
3. Y. Cengel and M. Boles, Thermodynamics - An Engineering Approach, Tata McGrawHill,7th Edition, 2011.

REFERENCE BOOKS

1. Chattopadhyay, P, "Engineering Thermodynamics",2nd Ed. Oxford University Press, 2014.
2. Venkatesh. A, "Basic Engineering Thermodynamics", Universities Press (India) Limited,2007.
3. E. Rathakrishnan, "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006.
4. Van Wylen and Sonntag, "Classical Thermodynamics", Wiley Eastern, 1987.
5. E. Rathakrishnan, "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006.
6. Van Wylen and Sonntag, "Classical Thermodynamics", Wiley Eastern, 1987.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	2	2	2	3	2	3	2	2	1	2
CO2	3	2	1	1	2	2	1	2	1	1	1	1	2	2	2
CO3	3	1	2	1	1	1	1	1	2	2	1	2	2	2	2
CO4	2	1	3	2	2	1	1	1	1	1	2	1	2	2	2
CO5	3	1	1	2	1	2	1	2	2	1	1	1	2	2	2
Avg	2.8	1.4	1.6	1.6	1.4	1.6	1.2	1.6	1.8	1.4	1.6	1.4	2	1.8	2

- 1-low, 2-medium, 3-high, '-' - no correlation. Note: The average value of this course is to be used for the program articulation matrix.

COURSE OBJECTIVES

After successful completion of this course, the students will be able to:

1. Understand and use the engineering curves in engineering applications and projection techniques to construct conic curves, points and lines.
2. Develop skills in projecting surfaces and solids and create 2D models using CAD software.
3. Develop skills in 3D projection and 3D modeling of simple parts manually as well as using CAD software.
4. Understand and apply sectioning techniques to solids and assemble components.
5. Develop skills in lateral surface development and sheet metal design.

INTRODUCTION

Manual drawing tools (Mini Drafter, Set Squares, Protractor, Compass, and different grades of pencil). 'BIS' specifications and rules of Engineering Drawing – Arrows (2H thin line body, HB Filled head and L:W = 3:1 ratio), lettering (Digital fonts, font sizes pertaining to usage and representation), types of line and their syntax (Drawing based – Continuous thin & thick, dashed, dashed dotted and Application based – extension, dimensioning, construction, projection, reference, axis, section, hatching, and break lines), scaling (up, down and equal), and dimensioning. Placing and positioning the 'A3' size drawing sheet over the drawing table. Principal planes and projection, Division of line and circle in to equal parts, and construction of polygons

UNIT i: ENGINEERING CURVES, PROJECTION OF POINTS AND LINES 6+12

Construction of conic curves with their tangent and normal – ellipse, parabola, and hyperbola by eccentricity method

Construction of special curves with their tangent and normal – cycloid, epicycloid, and involute

Projection of points and I angle projection of lines inclined to both principal planes by rotating line method and trapezoidal rule – marking their traces.

Lab exercises: Study exercise – Introduction to Sketching (or) Drawing, and modification tools in CAD software (AutoCAD, CREO, CATIA, Solid Works, Inventor, Fusion 360)

Activities based learning: Identification of the curves used in the application given in the flash card, demonstration of the instantaneous centre of rotation of governors with respect to angle of inclination of the arms of the governors

UNIT II PROJECTION OF SURFACES & SOLIDS, AND 2D MODELING 6+12

Projection of surfaces inclined to both the principal planes – polygonal, trapezoidal, rhomboidal and circular

Projection of solids – prisms, pyramids, and axisymmetric solids when the axis inclined to both the principal planes – freely hanging – contour resting condition on either of the planes by rotating object method

Lab exercises: Construction of basic sketches – lines, circle, polygon, spline curves, coils, along with dimensioning. Familiarizing with geometric constraints and their types

Activities based learning: Making the solids using cardboards, shadow mapping and contour drawing at different orientation of the solids using torches,

UNIT III 3D PROJECTION OF SOLIDS AND 3D MODELING OF SIMPLE PARTS 6+12

Free hand sketching – I & III angle projections of engineering parts and components

Isometric projection of combination of solids – prisms, pyramids, axisymmetric solids, frustum

Perspective projection of prisms, pyramids and axisymmetric solids by visual ray method

Lab exercises: 3D Modeling and 2D drafting of machine parts

Activities based learning: Flipped classroom for Free hand sketching, Jig saw activity for Isometric projection, arts and crafts for perspective view

UNIT IV SECTION OF SOLIDS AND SECTIONED DRAFTING OF ASSEMBLED COMPONENTS 6+12

Section of simple and hollow solids – prisms, pyramids and axisymmetric solids, solids with holes/slots when the section plane perpendicular to one principal plane and inclined to other principal plane ('On the axis' and 'from the axis' conditions)

Application based – section of beams (I, T, L, and C), section of pipe bracket, wood joints, composite walls, shells, flange of a coupling and other similar applications

Lab exercises: Assembly of parts with respect to engineering constraints, and sectioned drafting of assembled components

Activities based learning: Making of mitered joint in wood, sectioning the beams in different angles of orientation and identifying the true shape

UNIT V LATERAL SURFACE DEVELOPMENT AND SHEET METAL DESIGN 6+12

Lateral surface development of sectioned solids when the section plane perpendicular to VP and inclined to HP.

Application based – construction of funnel, chimney, dish antenna, door latch, trays, AC vents, lamp shade, commercial packaging boxes with respect to sectioning conditions and other similar applications

Lab exercises: Sheet metal design and drafting, drafting of coils, springs and screw threads

Activities based learning: Fabrication of funnels, chimney, lamp shade, boxes using card boards, ply woods, acrylics

TOTAL: 90 HOURS

Note: Activities based learning should not be covered in the regular class hours. It should be given as assignments to the group of maximum 3 members

Question pattern suggestion: Part – A (Either or type) ($5 \times 16 = 80$) & Part – B (Compulsory) ($1 \times 20 = 20$)

COURSE OUTCOME:-

After successful completion of the course, the students will be able to:

CO1: Construct and identify different types of conic curves and special curves, and project the points and lines pertaining to engineering applications

CO2: Project and visualize surfaces and solids in different orientations and utilize the CAD tools for designing.

CO3: Create and draft accurate 3D models and 2D drawings of machine parts manually as well as using CAD softwares

CO4: Determine the true shape of a sectioned solid and draft the assemble parts accordingly

CO5: Develop lateral surfaces of sectioned solids and design sheet metal components

TEXTBOOKS:

1. "Engineering Drawing" by N S Parthasarathy and Vela Murali
2. "Engineering Drawing and Graphics with Auto CAD" by Venugopal K

REFERENCE BOOKS:

1. "Basic Engineering Drawing: Mechanical Semester Pattern" by Mehta and Gupta
2. "Engineering Drawing" by Basant Agrawal and C M Agrawal
3. "Engineering Drawing With Auto CAD" by B V R Gupta
4. "Engineering Drawing" by P S Gill
5. "Engineering Drawing with an Introduction to AutoCAD" by Dhananjay Jolhe
6. "Engineering Drawing" by M B Shah
7. "Fundamentals of Engineering Drawing" by Imtiaz Hashmi
8. "Computer Aided Engineering Drawing" by S Trymbaka Murthy
9. "CAED : Computer Aided Engineering Drawing for I/II Semester BE/Btech Courses" by Reddy K B
10. "Computer-Aided Engineering Drawing" by Subrata Pal

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2		1				3	1		3	3	3	2
2	3	3	2		2				3	2		3	3	3	2
3	3	3	3	1	2				3	3		3	3	3	2
4	3	3	3	1	3				3	3		3	3	3	2
5	3	3	3	1	3				3	3		3	3	3	2

UNIT-I BASIC ELECTRICAL CIRCUITS 6

Basic Elements: R,L,C- DC Circuits: Ohm's Law - Kirchhoff's Laws –Mesh and Nodal Analysis(Only Independent Sources). AC Circuits: Average Value, RMS Value, Impedance Instantaneous Power, Real Power, Reactive Power and Apparent Power, Power Factor-Steady state Analysis of RL,RC and RLC circuits.

UNIT II AC AND DC MACHINES 6

Magnetic Circuit Fundamentals -DC Machines - Construction and Working Principle, Types and Application of DC generator and Motor, EMF and Torque Equation. AC Machines: Principle, Construction, Working and Applications of Transformer -Three phase Alternator - Three Phase Induction Motor.

UNIT III ANALOG AND DIGITAL ELECTRONICS 6

Operation and Characteristics of electronic devices: PN Junction Diodes, Zener Diode and BJT Applications: Diode Bridge Rectifier and Shunt Regulator. Introduction to Digital Electronics: Basics Logic Gates-Flip Flops.

UNIT IV SENSORS AND TRANSDUCERS 6

Solenoids, electro-pneumatic systems, proximity sensors, limit switches, Strain gauge, LVDT, Piezo electric transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

UNIT V MEASUREMENTS AND INSTRUMENTATION 6

Functional Elements of an Instrument, Operating Principle of Moving Coil and Moving Iron Instruments,Power Measurement, Energy Meter, Instrument Transformers - CT and PT, Multimeter-DSO - Block Diagram Approach.

TOTAL 30**LAB COMPONENT:**

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Single Phase Transformer.
4. Load test on 3 Phase Induction Motor.
5. Uncontrolled diode bridge Rectifiers.
6. Application of Zener diode as shunt regulator.
7. Verification of truth table of logic gates and flip flops.
- 8.Characteristics of LVDT.
- 9.Three phase power measurement using two wattmeter method.
- 10.Study of DSO.

COURSE OUTCOMES:

Students will be able to

CO1

Compute the electric circuit parameters for simple circuits.

CO2

Understand the working principles and characteristics of electrical machines.

CO3

Understand the basic electronic devices.

CO4

Understand the basic operating principles of sensors and transducer.

CO5

Understand the operating principles measuring devices

TEXT BOOKS:

1. Kotharai DP and Nagarath IJ, "Basic Electrical and Electronics Engineering", McGraw Hill Education, Second Edition, 2020.
2. Bhattacharya SK, "Basic Electrical and Electronics Engineering", Pearson Education, Second Edition, 2017.

REFERENCES:

1. Mehta V.K. & Mehta Rohit, "Principles of Electrical Engineering and Electronics", McGraw Hill Education, Second Edition, 2020.
2. Mehta V.K. & Mehta Rohit, "Principles of Electrical Machines", S. Chand Publishing, second edition 2006.
3. Albert Malvino & David Bates, "Electronic principles", McGraw Hill Education, Seventh Edition, 2017.

Mapping COs and POs:																
COs	Pos											PSOs				
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	1														
CO2	2	1														
CO3	2	1														
CO4	2	1														
CO5	2	1														
Avg	2	1														

அலகு I மொழி மற்றும் இலக்கியம்

3

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை

3

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள்- பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:

3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்:

3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:

3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிக்கள் - தமிழ்ப் புத்தகங்களின் அச்ச வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருளை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UNIT I LANGUAGE AND LITERATURE**3**

Language Families in India-Dravidian Languages–Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural – Tamil Epics and Impact of Buddhism & Jainism in Tamil and – Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyarand Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE**3**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts-Art of temple car making - Massive Terracotta sculptures, Villagedeities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments-Mridhangam,Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS**3**

Therukoothu, Karagattam, VilluPattu, KaniyanKoothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAICONCEPTOFTAMILS**3**

Flora and Fauna of Tamils&AhamandPuramConceptfromTholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import duringSangamAge -Overseas Conquestof Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE**3**

Contribution of Tamils toIndian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - RoleofSiddhaMedicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS**TEXT-CUM-REFERENCEBOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International

Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

NCC Credit Course Level 1*

UC23P01	(ARMY WING) NCC Credit Course Level - I	L T P C
		2 0 0 2

NCC GENERAL	6
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NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2

NATIONAL INTEGRATION AND AWARENESS	4
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NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1

PERSONALITY DEVELOPMENT	7
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PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2

LEADERSHIP	5
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L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2

SOCIAL SERVICE AND COMMUNITY DEVELOPMENT	8
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SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P02	(NAVAL WING) NCC Credit Course Level – I	L T P C
		2 0 0 2
NCC GENERAL		6
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		4
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		7
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		5
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		8
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P03	(AIR FORCE WING) NCC Credit Course Level – I	L T P C
		2 0 0 2
NCC GENERAL		6
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		4
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		7
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		5
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		8
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1
TOTAL : 30 PERIODS		

SEMESTER – II

EN23C02

PROFESSIONAL COMMUNICATION

L T P C
2 0 2 3

COURSE OBJECTIVES:

- To read and comprehend different forms of official texts.
- To develop students' writing skills in professional context.
- To actively listen, read and understand written and oral communication in a professional context.
- To comprehend and analyse the visual content in authentic context.
- To write professional documents with clarity and precision

UNIT I CAUSE AND EFFECT 6

Reading – Newspaper articles on Social and Environmental issues; Writing – Instructions, Cause and effect essay; Grammar - Modal verbs; Vocabulary – Cause and effect, Idioms

LAB ACTIVITY: 6

Listening and Speaking – Listen to news reports and summarise in oral form.

UNIT II CLASSIFICATION 6

Reading – An article, social media posts and classifying based on the content; Writing – Definition, Note making, Note taking (Cornell notes etc.) and Summarising; Grammar – Connectives; Vocabulary – Phrasal verbs

LAB ACTIVITY: 6

Listening and speaking: Social interaction (Conversation including small talk)

UNIT III PROBLEM AND SOLUTION 6

Reading – Visual content (Tables/charts/graphs) for comprehension; Writing - Problem and Solution Essay; Grammar – If conditionals; Vocabulary – Sequential words.

LAB ACTIVITY: 6

Listening – Group discussion; Speaking – Participating in a group discussion

UNIT IV REPORT 6

Reading – Formal report on accidents (industrial/engineering); Writing – Industrial Accident report; Grammar – Active and passive voice, Direct and Indirect speech; Vocabulary – Numerical adjectives.

LAB ACTIVITY: 6

Listening / watching – Television documentary and discussing its content, purpose etc.

UNIT V JOB APPLICATION AND INTERVIEW 6

Reading - Job advertisement and company profile; Writing – Job application (cover letter and CV) Grammar – Mixed Tenses; Vocabulary – Collocations related to work environment

LAB ACTIVITY: 6

Listening – Job interview; Speaking – Mock interviews

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment

Written assessments

Assignment

Lab Assessment

Group discussion (Peer assessment)

Listening

External Assessment

End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- To apply appropriate language structure and vocabulary to enhance both spoken and written communication in formal contexts.
- Comprehend different forms of official documents
- Write professional documents coherently and cohesively.
- Interpret verbal and graphic content in authentic context
- Analyse and evaluate verbal and audio visual materials.

TEXT BOOKS:

1. "English for Engineers and Technologists" Volume 2 by Orient Blackswan, 2022
2. "English for Science & Technology - II" by Cambridge University Press, 2023.

REFERENCES:

1. "Communicative English for Engineers and Professionals" by Bhatnagar Nitin, Pearson India, 2010.
2. "Take Off – Technical English for Engineering" by David Morgan, Garnet Education, 2008.
3. "Advanced Communication Skills" by Mathew Richardson, Charlie Creative Lab, 2020.
4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		√
CO3										√		√
CO4										√		√
CO5										√		√

MA23C02	ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To acquaint the students with Differential Equations which are significantly used in engineering problems.
- To make the students to understand the Laplace transforms techniques.
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series.
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.
- To develop Z- transform techniques in solving difference equations.

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9+3

Homogeneous linear ordinary differential equations of second order -superposition principle - general solution- Particular integral - Operator method - Solution by variation of parameters - Method of undetermined coefficients - Homogeneous equations of Euler–Cauchy and Legendre’s type – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS 9+3

Existence theorem - Transform of standard functions – Transform of Unit step function and Dirac delta function – Basic properties - Shifting theorems - Transforms of derivatives and integrals – Transform of periodic functions - Initial and Final value theorem - Inverse Laplace transforms- Convolution theorem (without proof) – Solving Initial value problems by using Laplace Transform techniques.

UNIT III FOURIER SERIES 9+3

Dirichlet’s conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval’s identity – Computation of harmonics.

UNIT IV FOURIER TRANSFORMS 9+3

Fourier integral theorem – Fourier transform pair - Fourier sine and cosine transforms – Properties – Transform of elementary functions – Inverse Fourier Transforms - Convolution theorem (without proof) – Parseval’s identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 9+3

Z-transform – Properties of Z-transform – Inverse Z-transform – Convolution theorem – Evaluation of Inverse Z transform using partial fraction method and convolution theorem - Initial and final value theorems – Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

Ordinary differential equations

1. Symbolic computation of linear ordinary differential equations
2. Solving System of simultaneous linear differential equations using ODE SOLVER

Laplace transforms

1. Symbolic computation of Laplace transform and Inverse Laplace transform
2. Plotting Laplace transforms

Fourier Series

1. Symbolic computation of Fourier Coefficients
2. Computation of harmonics
3. Plotting truncated Fourier Series

Fourier Transform

1. Symbolic computation of Fourier Transforms
2. Plotting truncated Fourier Transforms

Z – transform

1. Symbolic computation of Z-Transforms

OUTCOMES:

CO1 :Solve higher order ordinary differential equations which arise in engineering applications.

CO2 :Apply Laplace transform techniques in solving linear differential equations.

CO3 :Apply Fourier series techniques in engineering applications.

CO4 :Understand the Fourier transforms techniques in solving engineering problems.

CO5 :Understand the Z-transforms techniques in solving difference equations.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, New Delhi, 2020.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.

REFERENCES:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education 2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, 5 th Edition, New Delhi, 2017.
4. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
5. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO 1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 5 :	3	3	2	3	1	2	1	1	1	1	1	3

UNIT I WATER TECHNOLOGY

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD, and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, Calgon, and carbonate treatment. External conditioning – demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration, disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis – desalination.

PRACTICAL:

- Estimation of HCl using Na_2CO_3 as the primary standard
- Determination of alkalinity in the water sample.
- Determination of hardness of water by EDTA method.
- Determination of DO content of water sample by Winkler's method.

UNIT II NANO CHEMISTRY

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro-spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials – medicine including AYUSH, automobiles, electronics, and cosmetics.

PRACTICAL:

- Preparation of nanoparticles by Sol-Gel method/sonication method.
- Preparation of nanowire by Electrospinning.
- Study of morphology of nanomaterials by scanning electron microscopy

UNIT III CORROSION SCIENCE

Introduction to corrosion – chemical and electrochemical corrosions – mechanism of electrochemical and galvanic corrosions – concentration cell corrosion-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion- measurement of corrosion rate. Electrochemical protection – sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

PRACTICAL:

- Corrosion experiment-weight loss method.
- Salt spray test for corrosion study.
- Corrosion prevention by electroplating.
- Estimation of corroded Iron by Potentiometry/UV-visible spectrophotometer

UNIT IV ENERGY SOURCES

Electrochemical cell, redox reaction, electrode potential – oxidation and reduction potential. Batteries – Characteristics; types of batteries; primary battery (dry cell), secondary battery (lead acid, lithium-ion battery) and their applications. Emerging energy sources – metal hydride battery, hydrogen energy, Fuel cells – H₂-O₂ fuel cell. Supercapacitors –Types and Applications, Renewable Energy: solar heating and solar cells. Recycling and disposal of batteries.

PRACTICAL:

- Study of components of Lead acid battery.
- Measurement of voltage in a photovoltaic cell.
- Working of H₂ – O₂ fuel cell

UNIT V POLYMER CHEMISTRY

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: T_g, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring. Polyamides, Polycarbonates and Polyurethanes – structure and applications. Recycling of polymers.

PRACTICAL:

- Determination of molecular weight of a polymer using Ostwald viscometer.
- Preparation of a polymer.
- Determination of molecular weight by Gel Permeation Chromatography.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

- CO1:** To demonstrate knowledge of water quality in various industries and develop skills in analyzing water quality parameters for both domestic and industrial purposes.
- CO2:** To identify and apply fundamental concepts of nanoscience and nanotechnology for engineering and technology applications, and to develop skills in synthesizing nanomaterials and studying their morphology.
- CO3:** To apply fundamental knowledge of corrosion protection techniques and develop skills to conduct experiments for measuring and preventing corrosion.
- CO4:** To study the fundamentals of energy storage devices and develop skills in constructing and experimenting with batteries.
- CO5:** To recognize and apply basic knowledge of different types of polymeric materials and develop skills in preparing and determining their applications for futuristic material fabrication needs.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., "A Textbook of Engineering Chemistry", Chand Publications, 2004.
4. Laboratory Manual - Department of Chemistry, CEGC, Anna University (2023).

REFERENCES:

1. Schdeva M.V., "Basics of Nano Chemistry", Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, "Engineering Chemistry", Medtech, 2014.
3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, "Polymer Science" New AGE International Publishers, 2009.
4. Vogel's Textbook of Quantitative Chemical Analysis (8th edition, 2014).

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	3	-	-	-	-	-
CO2	3	-	2	-	2	-	3	-	-	-	-	-
CO3	3	3	2	-	2	-	3	-	-	-	-	-
CO4	3	3	-	-	-	-	3	-	-	-	-	-
CO5	3	-	-	-	-	-	3	-	-	-	-	-
Avg	3	3	-	-	-	-	3	-	-	-	-	-

1' = Low; '2' = Medium; '3' = High

OBJECTIVES

The course aims to

- To develop the knowledge of students in the area of post-harvest processing of various foods and related technology.
- To enable students to appreciate the application of scientific principles in the processing of post-harvesting materials.

UNIT I INTRODUCTION**7**

Post-harvest engineering of crops – objectives - post-harvest systems and losses in agricultural commodities structure, engineering properties of agricultural materials, optimum stage of harvest, the importance of loss reduction; Post-harvest handling operations. Pre-drying operation, Moisture content, RH measurement, air-grain measurement.

UNIT II CLEANING, THRESHING AND GRADING**10**

Threshing and shelling operation - principles and operation - various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc. Cleaning – principles and machinery – Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens - rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Peeling, Sorting and Grading - grain grading system, the effectiveness of separation and performance index., hydrothermal treatment and conditioning of grains, Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency. Separation - Magnetic separator, de-stoners, electrostatic separators, pneumatic separator

UNIT III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE**10**

Introduction to different conveying equipment used for handling of grains, fruits, and vegetables; Scope and importance of material handling devices Classification, principles of operation, conveyor system selection/design. Belt conveyor Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper. Chain conveyor -Principle of operation, advantages, disadvantages, capacity, and speed, conveying chain. Screw conveyor Principle of operation, capacity, power, troughs, loading, discharge, inclined and vertical screw conveyors. Bucket elevator Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, the relationship between belt speed, pickup and bucket discharge, bucket types, and power requirement. Pneumatic conveying system types, air/product separators; Gravity conveyor design considerations, capacity, and power requirement.

UNIT IV PRINCIPLES AND PRACTICE OF STORAGE**10**

Importance of scientific storage systems, post-harvest physiology of semi-perishables and perishables. Damages Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects,

etc.), sources of infestation and control. Storage structures-Traditional storage structures, improved storage structures, modern storage structures; Farm silos Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos. Storage of perishables Cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside the storage.

UNIT V PEST CONTROL

8

Primary and secondary insect pests, rodents, and microorganisms of stored food grains and their control, integrated pest management, Fumigation, and controlled atmosphere storage of food grains, Rodent Control.

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

CO1 Apply the post-harvest engineering to prevent loss.

CO2 Infer the different cleaning, threshing, and grading operations involved in the food industry.

CO3 Utilize the conveyors in the food industry

CO4 Apply the storage principles in extending the shelf-life of commodity.

CO5 Identify the suitable pest control and management method for agricultural produce.

TEXTBOOKS

1. Sahay, K. M. and K.K.Singh..“Unit operation of Agricultural Processing”, Vikas Publishing House.,Pvt Ltd. 2004.
2. Chakravarty et al Handbook of Post-Harvest Technology Marcel Dekker. 2003.
3. Araullo, E.V., dePadna, D.B. and Graham, Michael. Rice Post Harvest Technology.International Development Res. Centre, Ottawa, Canada. 1976.
4. Birewar, B.R., Krishnamurthy, K., Girish, G.K., Varma, B.K. and Kanjilal, S.C.. Modern Storage Structures. Indian Grain Storage Institute, Hapur.1983.
5. Earle, R.L, “Unit Operations in Food Processing”. Pergamon Press. Oxford. U.K, 2003

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	1	2	1	2	2	2	3	2	3	2	2	1	2
CO2	2	1	1	1	2	2	1	2	1	2	1	2	3	3	2
CO3	2	3	2	2	2	1	2	1	2	2	1	2	2	2	2
CO4	2	2	1	2	2	1	2	3	2	1	2	1	2	3	3
CO5	3	1	1	1	1	2	1	2	2	1	1	1	2	2	1
Avg	2	1.8	1.2	1.6	1.6	1.6	1.6	2	2	1.6	1.6	1.6	2.2	2.2	2

- 1-low, 2-medium, 3-high, ‘-’ - no correlation. Note: The average value of this course is to be used for the program articulation matrix.

COURSE OBJECTIVES:

1. To practice the usage of various tools towards assembly and dis-assembly of different items / equipment.
2. To make simple part / component using welding processes.
3. To train on the basic wiring practices of boards, machines, etc.
4. To provide a hands-on experience on the use of electronic components, equipment, sensors and actuators.
5. To expose to modern computer tools and advanced manufacturing / fabrication processes.

LIST OF ACTIVITIES**1L,4P****(A). Dis-assembly & Assembly Practices**

- i. Tools and its handling techniques.
- ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.
- iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.
- iv. Dis-assembly and assembly of a Bicycle.

(B). Welding Practices

- i. Welding Procedure, Selection & Safety Measures.
- ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.
- iii. Hands-on session of preparing base material & Joint groove for welding.
- iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Steel plates / pipes, for fabrication of a simple part.

(C). Electrical Wiring Practices

- i. Electrical Installation tools, equipment & safety measures.
- ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box,
- iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.
- iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.

(D). Electronics Components / Equipment Practices

- i. Electronic components, equipment & safety measures.
- ii. Dis-assembly and assembly of Computers.
- iii. Hands-on session of Soldering Practices in a Printed Circuit Breaker.
- iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier.
- v. Hands-on session of integration of sensors and actuators with a Microcontroller.

- vi. Demonstration of Programmable Logic Control Circuit.

(E).Contemporary Systems

- i. Demonstration of Solid Modelling of components.
- ii. Demonstration of Assembly Modelling of components.
- iii. Fabrication of simple components / parts using 3D Printers.
- iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.

TOTAL: 75 Periods (15 Lecture + 60 Practical)

COURSE OUTCOMES:

Upon the successful completion of the course, students will be able to:

- CO1: Assemble and dis-assemble various items / equipment.
- CO2: Make simple parts using suitable welding processes.
- CO3: Setup wiring of distribution boards, machines, etc.
- CO4: Utilise the electronic components to fabricate a simple equipment, aided with sensors and actuators.
- CO5: Take advantage of modern manufacturing practices.

REFERENCES:

1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.
3. Code of Practice for Electrical Wiring Installations (IS 732:2019)
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 7th ed. (Indian edition), 2017.
5. Mazidi, Naimi, Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson India, 1st edition 2013.
6. Visualization, Modeling, and Graphics for Engineering Design, D.K. Lieu, S.A. Sorby, Cengage Learning; 2nd edition.

COURSE OBJECTIVES:

- To understand fundamental structural programming concepts and problem-solving process.
- To solve problems using modular programming and decomposition techniques.
- To solve problems using data structures and abstraction techniques.
- To create programming solutions using libraries and packages.
- To design solutions to domain problems using programming problem-solving techniques.

UNIT I – STRUCTURED PROGRAMMING**9+6**

Problem-Solving Strategies. Basic Problem-Solving Tools: Flowcharts, Pseudocode. Introduction to Programming Languages and Development Environments. Programming. Basic Concepts and Syntax: Variables, Identifiers, Data Types: Primitive Types and Strings, Statements, Operators, Expressions and its evaluation, Operator Precedence, Basic Arithmetic Operations. Principles of Structured Programming – Control Structures: Sequence, Selection, Iteration and Branching.

PRACTICALS:

- Design algorithms for simple computational problems
- Create Pseudo-code and Flow charts for simple computational problems
- Create Python programs using simple and nested selective control statements
- Create Python programs using simple and nested sequence & iterative control statements
- Create Python programs to generate series/patterns using control statements

UNIT II – MODULARITY AND DECOMPOSITION**9+6**

Principles of Modular and Decomposition. Functions: Defining functions –Argument types – Function Name-spaces – Scoping: Global and Non-local. Principles of Recursion: Base case and Recursive cases – Develop and Analyze Recursive functions: Factorial, Fibonacci. Principles of First-Class and Higher-Order functions: Lambda functions – Functions as arguments.

PRACTICALS:

- Create Python programs using functions
- Create python program using recursion
- Create Python programs using lambda functions
- Create Python programs using first-class functions
- Create Python programs using higher-order functions

UNIT III – DATA STRUCTURES AND ABSTRACTIONS**9+6**

Principles of Data Structures and Abstractions. String Methods and Manipulations,.Lists: List Operations and Methods, List comprehensions, Nested List comprehensions, Matrix operations using Lists. Tuples and sequences. Sets and Operations. Dictionaries: Dictionary operations, Dictionary comprehensions, Nested Dictionary comprehensions. Comparing Data Structures. Search and Sort Data Structures. Principle of Functional Programming and Tools : map, filter, and reduce.

PRACTICALS:

- Create Python programs for strings manipulations.
- Design Python programs using Lists, Nested Lists and Lists comprehensions
- Create Python programs using Tuples, Nested Tuples, and Tuple comprehensions
- Create Python programs creating Sets and performing set operations
- Create Python programs using Dictionary, Nested Dictionary and comprehensions
- Create Python programs by applying functional programming concepts

UNIT IV – LIBRARIES AND MODULES

9+6

Exceptions: Syntax errors, Exceptions, Exception types, Handling exceptions, Raising exceptions. Files: File Path, Type of files, opening modes, Reading and Writing text files, Handling other format Data files. Modules: Creating Modules, import and from statements, Executing modules as scripts, Standard modules. Packages and Importing from packages

PRACTICALS:

- Design Python programs to handle errors and exceptions
- Create, import, and use pre-defined modules and packages
- Create, import, and use user-defined modules and packages
- Create Python programs to perform various operations on text files
- Create Python programs to perform various operations on other data file formats.

UNIT V – SIMPLE PROBLEM SOLVING TECHNIQUES IN PROGRAMMING

9+6

Data Structures for Problem Solving: Stack, Queue. Principles of Divide and Conquer: Binary Search. Principles of Greedy Algorithms: Minimum Coin Change Problem. Case studies on programming application of problem-solving techniques in different fields of engineering.

PRACTICALS:

- Create python programs to implement stack and queue.
- Create python programs to implement binary search.
- Create python programs to solve minimum coin change problem.
- Case study on developing python solution to a domain specific problems.

TOTAL = 45 + 30 = 75 PERIODS

Course Outcomes

1. Understand fundamental structural programming concepts and problem-solving process.
2. Solve problems using modular programming and decomposition techniques.
3. Solve problems using data structures and abstraction techniques.
4. Create programming solutions using libraries and packages.
5. Design solutions to domain problems using programming problem-solving techniques.

TEXT BOOKS

1. Reema Thareja, Python Programming using Problem Solving Approach, Oxford University Press, First Edition, 2017.
2. S. Sridhar, J. Indumathi, V. M. Hariharan, Python Programming, Pearson Education, First Edition, 2023

REFERENCE BOOKS

1. Paul Deitel, Harvey Deitel, Python for Programmers, Pearson Education, 2020.
2. John V Guttag. Introduction to Computation and Programming Using Python, With Application to Computational Modeling and Understanding Data. Third Edition, The MIT Press, 2021
3. Mark Lutz, Learning Python, 5th Edition, O'Reilly Media, Inc.
4. Python official documentation and tutorial, <https://docs.python.org/3/>
5. Numerical Python official documentation and tutorial, <https://numpy.org/>

CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		2		1								1	1	
2	2		2		1								1	1	
3	2	1	2		1								1	1	
4	2	1	2	1	1								1	1	
5	2	1	2	1	1								1	1	
Avg	2	1	2	1	1								1	1	

1 - low, 2 - medium, 3 - high, '-' - no correlation

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: 3

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III உற்பத்தித் தொழில் நுட்பம்: 3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: 3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குழுவித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: 3

அறிவியல் தமிழின் வளர்ச்சி – கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS**TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H02

TAMILS AND TECHNOLOGY

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UNIT I WEAVING AND CERAMIC TECHNOLOGY

3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY

3

Designing and Structural construction House & Designs in household materials during Sangam Age -Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period -Type study (Madurai Meenakshi Temple)- Thirumalai NayakarMahal -ChettiNadu Houses, Indo-Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY

3

Art of Ship Building - Metallurgical studies -Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stonebeads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY

3

Dam, Tank, ponds, Sluice, Significance of KumizhiThoompuof Chola Period,Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing -KnowledgeofSea -Fisheries – Pearl - Conche diving - Ancient Knowledge ofOcean -KnowledgeSpecificSociety.

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

MA23C06	PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX FUNCTIONS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To familiarize the students to solve of partial differential equations.
- To familiarize the students in solving boundary value problems.
- To understand the concepts of Complex functions.
- To familiarize complex mappings and its property.
- To familiarize the students with integration of complex functions.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Lagrange’s Linear equation – Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous partial differential equations.

UNIT II APPLICATIONS OF FOURIER SERIES TO PARTIAL DIFFERENTIAL EQUATION 9+3

Classification of partial differential equations- Method of separation of variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two dimensional heat equation – Fourier series solutions in Cartesian coordinates.

UNIT III ANALYTIC FUNCTIONS 9+3

Limit, Continuity and Differentiation of Complex functions - Analytic functions – Necessary and sufficient conditions for analyticity - Properties of analytic functions – Harmonic conjugates – Construction of analytic function – elementary analytic functions (exponential, trigonometric, logarithm) and their properties.

UNIT IV CONFORMAL MAPPING 9+3

Introduction to complex mapping - Conformal mapping – Condition for conformality – Standard mappings: $a+z$, az , $az+b$, $\frac{1}{z}$, z^2 , e^z - Bilinear transformations – Physical applications: Fluid flow and heat flow problems.

UNIT V INTEGRATION OF COMPLEX FUNCTIONS 9+3

Line integral - Cauchy’s integral theorem – Cauchy’s integral formula – Taylor’s and Laurent’s series – Singularities – Residues – Cauchy’s Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contours (excluding poles on real lines).

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

1. Symbolic computation of solution to PDE using PDE Solver
2. Conformal mapping can be done by plotting the curves and surfaces

OUTCOMES:

CO1 :Understand the concepts of partial differential equations in practical situations.

CO2 :Obtain the solutions of the partial differential equations using Fourier series.

CO3 :Understand the Concepts of complex functions in practical situations.

CO4 :Understand the conformal mapping and its applications.

CO5 :Apply the complex integrations in engineering problems.

TEXT BOOKS:

1. Erwin Kreyszig "Advanced Engineering Mathematics", John Wiley & Sons., New Delhi, 2015.
2. Wylie C. R. and Barrett L. C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019.
3. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.

REFERENCES:

1. Mathews J. H. and Howell R. W "Complex Analysis for Mathematics and Engineering", Narosa Publishing House. New Delhi, 2012.
2. Peter V.O Neil "Advanced Engineering Mathematics", Cengage., New Delhi, 2016.
3. Dennis G Zill "Advanced Engineering Mathematics", Jones & Bartlett India P Ltd., New Delhi, 2017.
4. Dean G Duffy "Advanced Engineering Mathematics with MATLAB", CRC., USA, 2010.
5. Spiegel, M.R., Theory and Problems of Complex Variables and its Application (Schaum's Outline Series), McGraw Hill Book Co., Singapore (1981).

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

OBJECTIVES

The course aims to equip students to examine the food spoilage microorganisms and to detect the food pathogens along with the usage of various microbial techniques for their characterization.

UNIT I MICROBES – STRUCTURE AND MULTIPLICATION**9+12**

Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light, and electron microscopy; principles of different staining techniques like Gram staining, acid fast, capsule staining and flagella staining. Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules. Calculation of doubling time of bacteria.

PRACTICALS

- Culture techniques, isolation, and preservation of cultures – Broth flask, test tubes, solid pour plates, streak plates, slants, and stabs.
- Microscopic methods in the study of microorganisms; staining techniques – Simple and differential – Gram staining.

UNIT II ROLE OF MICROBES IN SPOILAGE OF FOODS AND THEIR CONTROL**9+12**

Factors affecting spoilage of foods, Microbial flora associated with various food groups their spoilage potential. Microbiological spoilage problems associated with typical food products. Use of antimicrobial chemicals – organic acids, sugars, sodium chloride, nitrites, phosphates, sulphites, benzoates, sorbates / propionates naturally occurring antimicrobials; Physical methods – low and high temperatures, drying, radiation and high pressure; Tolerance of microbes to chemical and physical methods in various foods.

PRACTICALS

- Quantification of microbes: Sampling and serial dilution; Bacterial count in food products: Total Viable Count (TVC).
- To analyse the microbiological quality of water (MPN) and milk.

UNIT III BENEFICIAL MICROBES IN FOODS**9+12**

Microbes of importance in food fermentations – Homo & hetero-fermentative bacteria, yeasts, and fungi; Biochemistry of fermentations – pathways involved, Lactic acid bacteria fermentation and starter cultures, Alcoholic fermentations – Yeast fermentations - Characteristics and strain selection, Fungal fermentations. Microbes associated with typical food fermentations – yoghurt, cheese, fermented milks, breads, idli, soy products, fermented vegetables, and meats.

PRACTICALS

- Enumeration of lactic acid bacteria from fermented foods.
- Yeast & mould count from fruits.

UNIT IV MICROBIAL AGENTS OF FOOD-BORNE ILLNESS

9+12

Food borne infections and food poisoning, Microbial toxins – types, Gram-negative and Gram-positive food-borne pathogens – *Salmonella*, *E. coli*, *Shigella*, *Vibrio cholerae*, *Staphylococcus aureus*; *Clostridium botulinum*; *Listeria monocytogenes*. Toxigenic algae and fungi; Food borne viruses; helminths, nematodes, and protozoa.

PRACTICALS

- Enumeration of spores from spices.
- Inhibitory effect of spices on microbial load in fish & flesh foods.

UNIT V MICROBIAL EXAMINATION OF FOODS

9+12

Detection & enumeration of microbes in foods, Most probable number calculations; Indicator organisms and microbiological criteria; Rapid and automated microbial methods – development and impact on the detection of food borne pathogens; Applications of immunological techniques, Importance of *Clostridium botulinum* to food industry; Detection methods for *E. coli*, *Staphylococci*, *Yersinia*, *B. cereus*, *C. botulinum* & *Salmonella*, *Listeria monocytogenes*, Norwalk virus, Rotavirus, Hepatitis A virus from food samples.

PRACTICALS

- Enumeration & isolation of *E. coli* from processed meat/chicken.
- Thermal destruction of microbes TDT & TDP.

TOTAL: 105 HOURS (45+60)

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

CO1 Perform microscopic and staining techniques and analyze the bacterial growth.

CO2 Understand the factors affecting food spoilage and use of physical and chemical methods to control the microbes.

CO3 Apply the knowledge of microorganisms in the process of fermentation.

CO4 Identify food-borne infection and food poisoning.

CO5 Perform the techniques to detect and enumerate the microorganisms in food.

TEXTBOOKS

1. Prescott Harley, Klein "Microbiology" 10th Edition (2017), McGraw-Hill Higher Education.
2. Ananthanarayanan, R. and C.K. Jayaram Paniker, "Textbook of Microbiology", 9th Edition, Orient Longman, 2013.
3. Vijaya Ramesh "Food Microbiology", MJP Publishers, 2007.
4. Jay, J.M. "Modern Food Microbiology", 4th Edition. CBS Publishers, 2003. Adams, M.R and M.O. Moss. "Food Microbiology", New Age International, 2002.

REFERENCE BOOKS

1. Pawsey, R.K. "Case Studies in Food Microbiology for Food Safety and Quality", Royal Society of Chemistry, 2001.
2. Orsythe, S.J. "The Microbiology of Safe Food", Blackwell Science, 2000.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	1	2	2	3	2	2	1	3	3	1
CO2	1	3	1	3	1	2	1	1	1	2	1	1	3	3	2
CO3	3	2	1	1	1	1	1	1	1	2	2	1	3	3	3
CO4	2	1	1	3	2	1	1	1	2	2	1	1	3	3	3
CO5	1	3	1	2	1	1	2	1	1	2	2	2	3	3	3
Avg	2	2	1.2	2	1.2	1.2	1.4	1.2	1.6	2	1.6	1.2	3	3	2.4

- 1-low, 2-medium, 3-high, '-' no correlation. The average value of this course to be used for program articulation matrix.

OBJECTIVES

The course aims to give students a solid foundation in biomolecules with their metabolic pathways and the roles of each nutrient in metabolism and growth.

UNIT I INTRODUCTION TO BIOMOLECULES**7+6**

Basic principles of organic chemistry, isomers, and stereoisomers, types of functional groups in biomolecules, types of bonds and interaction in biomolecules, chemical nature of water, pH, and mechanism of action of buffers in biological system.

PRACTICALS

- Preparation of buffer – titration of a weak acid and a weak base.

UNIT II STRUCTURE AND PROPERTIES OF IMPORTANT BIOMOLECULES**11+24**

Carbohydrates mutarotation, glycosidic bond, reactions of monosaccharides and reducing sugars, starch, glycogen, cellulose, and chitin. Proteoglycans, glycosaminoglycans. hyaluronic acid, chondroitin sulfate. Lipids – fatty acids, glycerol, triacylglycerol, phospholipids, glycolipids, sphingolipids. Inherited metabolic disorders of lipid metabolism – Tay-Saach's disease, Niemann- Pick's disease, and Gaucher's disease. Cholesterol, steroids, bile acids and salts, gluco- and minerals- corticosteroids. Prostaglandins and their functions. Lipoproteins. Cardiovascular disease and correlation with circulating lipid and lipoprotein concentration. Amino acids, peptides, and proteins. Classification based on side-chain properties. Structures, hierarchy of organization – primary, secondary, tertiary, and quaternary structures, glycoproteins, lipoproteins. Nucleic acids – purines, pyrimidines, nucleosides, nucleotides, Chargaff's rules. Base pairing, A-T and G-C, mRNA, rRNA, and tRNA. Watson-Crick structure of DNA, reactions, properties, T_m and hypochromicity, measurement of DNA and RNA. Nucleoprotein complexes.

PRACTICALS

- Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars.
- Quantitative method for amino acid estimation using ninhydrin.
- Protein estimation by Biuret, Lowry's, Bradford, and spectroscopic methods.
- Extraction of lipids and analysis by TLC.

UNIT III AN OVERVIEW OF NUTRITION AND ENERGY BALANCE**9+18**

Definition, six classes of nutrients, calculating energy values from food, using the RDA, nutritional status, nutritional requirement, malnutrition, nutritional assessment of individuals and populations, dietary recommendations, Balanced diet planning, dietary guidelines, glycemic and non-glycemic carbohydrates, health effects of fiber and starch intake food groups, exchange lists, personal diet analysis, digestion, absorption and transport – anatomy and physiology of the digestive tract, and absorption of nutrients. Energy balance, body weight and body composition, health implications, obesity, BMR, and BMI calculations.

PRACTICALS

- Nutritional anthropometry - Standards for reference – WHO, Body Mass Index and Reference

Value.

- Techniques of measuring height, weight, head, chest, and arm circumference, waist-to-hip ratio, and skin-fold thickness.
- Calculation of the calories from nutrient composition of foods.

UNIT IV VITAMINS AND MINERALS

9+6

Nutritional and biochemical roles of vitamins and minerals. Food sources, daily requirements, absorption, biochemical & physiological roles, deficiencies, and toxicity. Water Soluble Vitamins – vitamin C, B complex vitamins, fat-soluble vitamins – A, D, E, and K – function, recommended intakes, toxicities, food sources of vitamin A, D, E, and K, and vitamin E. Water balance and recommended intakes, fluid/electrolyte balance, food sources, absorption, biochemical function, recommended intakes, deficiencies of minerals, sodium, potassium, phosphorus, calcium, iodine, iron, zinc, selenium, copper, fluoride, and chromium.

PRACTICALS

- Quantitate estimation of vitamin C

UNIT V INTERMEDIARY METABOLISM AND REGULATION

9+6

Enzymes, introduction to biocatalysts, metabolic pathways, primary and secondary metabolites. Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt, glyoxalate shunt. Fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination, and decarboxylation, urea cycle, Bioenergetics – high energy compounds, the electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose and fatty acids.

PRACTICALS

- Enzymatic assay – phosphatase from potato.

TOTAL: 105 HOURS (45+60)

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

CO1 Understand the basics of biomolecules.

CO2 Evaluate the structural properties of carbohydrates, lipids, amino acids, and nucleic acids.

CO3 Understand and analyze the energy balance in a nutritional diet.

CO4 Evaluate and demonstrate the nutritional importance of vitamins and minerals.

CO5 Understand and analyze the metabolism and regulations in a living organism.

TEXTBOOKS

- Nelson, D.L. and M.M. Cox, "Lehninger's Principles of Biochemistry", 4th Edition, W.H. Freeman & Co., 2005.
- Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2006.
- Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.

REFERENCE BOOKS

- Berg, Jeremy M. et al. "Biochemistry", 6th Edition, W.H. Freeman & Co., 2006.
- Voet, D. and Voet, J.G., "Biochemistry", 3rd Edition, John Wiley & Sons Inc., 2004.

- Gropper, Sareen S. and Jack L. Smith “Advanced Nutrition and Human Metabolism”. 5th Edition. Wadsworth Publishing, 2008.
- Mann, Jim, and Stewart Truswell “Essentials of Human Nutrition”. 3rd Edition. Oxford University Press, 2007.
- Gibney, Michael J., et al., “Introduction to Human Nutrition”. 2nd Edition. Blackwell, 2009.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	1	1	1	1	2	2	3	1	2	1
CO2	2	2	2	3	2	1	2	1	3	2	1	1	2	2	1
CO3	2	2	2	3	2	1	1	1	2	1	3	2	2	2	1
CO4	2	2	2	3	1	1	1	1	2	2	1	1	2	2	1
CO5	2	2	2	3	1	1	1	1	1	2	2	1	2	2	1
Avg	2	1.8	1.8	2.6	1.4	1	1.2	1	1.8	1.8	1.8	1.6	1.8	2	1

1-low, 2-medium, 3-high, ‘- ‘- no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The course aims to understand the various units and dimensions along with mass and energy balance in unit operations and process involved in food industry.

UNIT I UNITS AND DIMENSIONS**9**

Units and Dimensions Basic and derived units, use of model units in calculations, Methods of expression, compositions of mixture and solutions. Ideal and real gas laws – Gas constant - calculations of pressure, volume and temperature using ideal gas law.

UNIT II HUMIDITY CALCULATIONS**9**

Fundamental food process Calculations and Humidity Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying of foods - Humidity chart, dew point.

UNIT III STOICHIOMETRY AND MATERIAL BALANCE**9**

Basic Principles of Stoichiometry - Importance of material balance and energy balance in a food Industry-Dimensions, Units, conversion factors and their use –Data sources, Humidity and applications. Material Balance Stoichiometric principles, Application of material balance in food operations like distillation, evaporation, crystallization, drying, extraction, Leaching.

UNIT IV ENERGY BALANCE**9**

Energy Balance Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats for food products.

UNIT V ENTHALPY**9**

Enthalpy Changes Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems without chemical reaction. (Use of Psychometric chart is permitted in the examination)

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO1 Apply various unit and dimensions to understand ideal gas laws.

CO2 Perform fundamental food process calculations.

CO3 Understand the basic principles of stoichiometry and material balance.

CO4 Calculate energy balance in foods.

CO5 Solve enthalpy changes in heat reactions.

TEXTBOOKS

1. Bhatt, B.L and Vora, S.M., —Stoichiometry, 5thEdition, McGraw-Hill, New York, 2010.

- Gavhane, K.A —Introduction to Process Calculations (Stoichiometry) Nirali Prakashan Publications, Pune, 2006.

REFERENCE BOOKS

- Venkataramani, V. and Anantharaman, N., —Process Calculations, Prentice Hall of India, New Delhi, 2003.
- Himmelblau, D.M., —Basic Principles and Calculations in Chemical Engineering, Sixth Edition, Prentice Hall India, New Delhi, 2003

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	3	1	2	2	2	1	2	1	1	2	1	1
CO2	3	2	1	1	2	1	1	2	1	2	1	1	2	2	1
CO3	3	1	1	1	1	1	1	1	2	2	1	2	2	1	1
CO4	2	1	1	2	2	1	1	1	2	1	2	1	2	1	1
CO5	3	1	1	1	1	1	1	1	2	1	1	1	2	1	1
Avg	2.8	1.2	1	1.6	1.4	1.2	1.2	1.4	1.6	1.6	1.2	1.2	2	1.2	1

- 1-low, 2-medium, 3-high, '-' no correlation. The average value of this course to be used for program articulation matrix.

COURSE OBJECTIVES:

To enable the students to understand the,

- The mechanics of fluids through a thorough understanding of the properties of the fluids, behaviour of fluids under static conditions.
- Dynamics of fluids is introduced through the control volume approach which gives an integrated understanding of the transport of mass, momentum and energy.
- Applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on vanes.
- Mechanical and Contact equilibrium separation processes of the components and their series of unit operations.

UNIT I PROPERTIES OF FLUIDS**12**

Properties of fluids – definition – units of measurement - Mass density – specific weight, specific volume – specific gravity equation of state – perfect gas - Viscosity – vapour pressure – compressibility and elasticity surface tension – capillarity. Basic equation of fluid statics; pressure variation in a static field; pressure measuring devices– manometer, U-tube, inclined tube, force on submerged bodies (straight, inclined), center of pressure. Basic equations in integral form: Basic laws for a system; continuity equation- in Cartesian co-ordinates - Euler's equation of motion, momentum balance equation-Introduction to Navier Stoke's and Euler's Equation, Types of fluid flow- Introduction to rotational and irrotational flow, momentum correction factor. Fluid pressure and measurement –simple, differential and micro manometers - Mechanical gages – calibration. Pressure diagram – total pressure on curved surface. Archimedes principles.

PRACTICALS:

- Calibration of Orifice meter
- Calibration of Venturimeter and Rotameter

UNIT II FLOW MEASUREMENTS & OPEN CHANNEL FLOW**12**

Introduction; flow of incompressible fluid in circular pipe; laminar flow for Newtonian fluid; HagenPoiseuille equation; introduction to turbulent flow in a pipe-Prandtl mixing length; energy consideration in pipe flow, Bernoulli's equation–kinetic energy correction factor; Reynold's experiment, Darcy – Weisbach equation for friction head loss – Chezy's formula – Manning's formula – Hazen-William's formula - Major and minor losses in pipes; friction factor-Fanning and Darcy, Moody diagram; major and minor losses; Pipe fittings and valves, equivalent diameter. Flow measurement: Introduction; general equation for internal flow meters; Orifice meter; Venturi meter; Weirs, concept of area meters: rotameter; Local velocity measurement: Pitot tube. Hot wire anemometer, mass flowmeter.

PRACTICALS:

- Flow through helical coil
- Flow through annular pipe

UNIT III DIMENSIONAL ANALYSIS & PUMPS**12**

Dimensional analysis – concept of geometric, kinematic and dynamic similarity. Important nondimensional numbers – Reynolds, Froude, Euler, Mach and Weber. Fluidization: Introduction; different types of fluidizations; minimum fluidization velocity; governing equation; pneumatic conveying and other industrial uses. Fluid moving machines: Basic classification of pumps: Non Mechanical Pumps-steam jet ejector, air lift pump, Mechanical pump: Centrifugal pumps cavitation, NPSH, Positive displacement pumps (rotary, piston, plunger, diaphragm

pumps); pump specification; basic characteristics curves for centrifugal pumps; fan, blower and compressor.

PRACTICALS:

- Hydrodynamics of fluidized bed
- Pressure drop studies in packed column

UNIT IV SEPARATION AND SIZE REDUCTION

12

Filtration –filter media –constant rate filtration – constant pressure filtration – filter cake resistance filtration equipment – rotary vacuum filter – filter press- sedimentation – Stoke’s law, sedimentation of particles in gas-cyclones – rate of separations – centrifuge equipment. Crystallization – equilibrium -solubility and equilibrium diagram – rate of crystal growth – equilibrium crystallization equipment – classification of distillation –Swenson-Walker vacuum crystallizers- Size reduction – grinding and cutting –Rittinger’s, Bond’s and Kick’s laws for crushing-size reduction equipment – crushers – jaw crusher, gyratory crusher-crushing rolls – grinders – hammer mills – rolling compression mills - attrition, rod, ball and tube mills – construction and operation.

PRACTICALS:

- Batch filtration studies using a leaf filter
- Batch filtration studies using a plate and frame filter press

UNIT V CONTACT EQUILIBRIUM SEPARATION

12

Contact equilibrium separation processes – concentrations – gas-liquid and solid-liquid equilibrium – equilibrium concentration relationships – operating conditions-calculation of separation in contact – equilibrium processes-gas absorption – rate of gas absorption –equilibrium gas – absorption equipment-properties of tower packing – types – construction – flow through packed towers extraction – rate of extraction extractor-extraction of fine material – Dorr agitator – continuous leaching – decantation systems – extraction towers-washing – equipment.

PRACTICALS:

- Reduction ratio in jaw crusher
- Reduction ration in ball mill

TOTAL: 60 PERIODS

COURSE OUTCOMES (COs):

At the end of the course

CO1 Understand the properties of fluid in static, kinematic and dynamic equilibrium.

CO2 Derive and apply basic equations of fluid flow

CO3 Apply the physical laws in flow measurements and hydraulics

CO4 Analyze the types of flow in various channels

CO5 Select and evaluate the performance of pumps.

TEXT BOOKS:

1. Modi, P.N. and Seth S.M. “Hydraulics and fluid mechanics”. Standard Publishers Distributors, New Delhi,2010.
2. Streeter, V.L. Wylie, E. B. and Bedford K.W, Fluid Mechanics. (9th ed) Tata McGraw Hill, New Delhi, 1998.
3. Geankoplis, C.J. “Transport Processes and Separation Process Principles”, 4th Edition, Prentice Hall, 2003.
4. McCabe W.L., Smith J.C. “Unit Operations in Chemical Engineering”, 7th Edition, McGraw – Hill Int., 2001.
5. Earle, R.L. 2003. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K. 6. Geankoplis C.J.1999. Transport Process and Unit Operations. Prentice-Hall of India Private Limited, New Delhi.

REFERENCES:

1. Bansal, R.K., “A text book of fluid mechanics and hydraulic machinery”, Laxm publications (P) Ltd., New Delhi, 2002.

2. Grade, R.J., "Fluid mechanics through problems". Wiley eastern Ltd., Madras, 2002.
3. Jain A. K. "Fluid Mechanics". Khanna Publishers 1995.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	3	1	1	2	1	2	1	1	1	3	3	2
CO2	3	1	1	2	1	1	1	1	2	2	1	1	3	1	1
CO3	3	1	1	2	1	2	1	1	2	1	2	1	3	1	3
CO4	2	1	1	2	2	1	1	1	1	1	2	2	3	1	3
CO5	3	1	2	1	1	1	1	1	2	1	1	1	3	1	3
Avg	2.8	1	1.2	2	1.2	1.2	1.2	1	1.8	1.2	1.4	1.2	3	1.4	2.4

MODULE I – INTRODUCTION**6**

Principles & Historical perspectives, Importance and need for sustainability in engineering and technology, impact and implications. United Nations Sustainability Development Goals (SDG), UN summit – Rio & outcome, Sustainability and development indicators.

MODULE II – ENVIRONMENTAL SUSTAINABILITY**6**

Climate change, Biodiversity loss, Pollution and waste management, Renewable vs. non-renewable resources, Water and energy conservation, Sustainable agriculture and forestry. National and international policies, Environmental regulations and compliance, Ecological Footprint Analysis

MODULE III – SOCIAL & ECONOMIC SUSTAINABILITY**9**

Equity and justice, Community development, Smart cities and sustainable infrastructure, Cultural heritage and sustainability, Ethical considerations in sustainable development.

Triple bottom line approach, Sustainable economic growth, Corporate social responsibility (CSR), Green marketing and sustainable product design, Circular economy and waste minimization, Green accounting and sustainability reporting.

MODULE IV – GREEN TECHNOLOGIES FOR SUSTAINABLE FOOD PRODUCTION**9**

Characteristics and principles of sustainable food production, urban agriculture, plant-based foods and food nanotechnology, reduction of greenhouse gas emissions, eutrophication of waterbodies, malnutrition, healthy diets, preserving biodiversity in food ecosystem, disposal of food products, food security, blockchain technology (BCT) based food supply chain, fossil fuels usage reduction and genetic diversity maintenance, renewable energy adoption, synthetic pesticides and fertilizers reduction.

MODULE V – SUSTAINABILITY PRACTICES**30**

Suggested Practices not limited to

- Energy efficiency – how to save energy (energy efficient equipment, energy saving behaviours).
- Chemical use and storage - the choice of chemicals being procured, the safe disposal of leftover chemicals, the impact of chemicals on the environment and long-term health impacts on humans.
- Green building, green building materials, green building certification and rating: green rating for integrated habitat assessment (GRIHA), leadership in energy and environmental design (LEED).
- Tools for Sustainability - Environmental Management System (EMS), ISO14000, life cycle assessment (LCA).
- Ecological footprint assessment using the Global Footprint Network spreadsheet calculator.
- National/Sub national Status of Sustainable Development Goals.

TOTAL: 45 HOURS**REFERENCES:**

1. Allen, D., & Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.
2. Munier, N. (2005). Introduction to sustainability (pp. 3558-6). Amsterdam, The Netherlands: Springer.
3. Blackburn, W. R. (2012). The sustainability handbook: The complete management guide to achieving social, economic and environmental responsibility. Routledge.
4. Clini, C., Musu, I., & Gullino, M. L. (2008). Sustainable development and environmental management.

Published by Springer, PO Box, 17, 3300.

5. Bennett, M., James, P., & Klinkers, L. (Eds.). (2017). Sustainable measures: Evaluation and reporting of environmental and social performance. Routledge.
6. Seliger, G. (2012). Sustainable manufacturing for global value creation (pp. 3-8). Springer Berlin Heidelberg.
7. Stark, R., Seliger, G., & Bonvoisin, J. (2017). Sustainable manufacturing: Challenges, solutions and implementation perspectives. Springer Nature.
8. Davim, J. P. (Ed.). (2013). Sustainable manufacturing. John Wiley & Sons.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	3	1	1	2	1	2	1	1	1	3	3	2
CO2	3	1	1	2	1	1	1	1	2	2	1	1	3	1	1
CO3	3	1	1	2	1	2	1	1	2	1	2	1	3	1	3
CO4	2	1	1	2	2	1	1	1	1	1	2	2	3	1	3
CO5	3	1	2	1	1	1	1	1	2	1	1	1	3	1	3
Avg	2.8	1	1.2	2	1.2	1.2	1.2	1	1.8	1.2	1.4	1.2	3	1.4	2.4

SEMESTER – IV

MA23C05	PROBABILITY AND STATISTICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
- To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables and the significance of the Central Limit theorem.
- To understand the basic concepts of sampling distributions and statistical properties of point and interval estimators.
- To apply the small/ large sample tests through Tests of hypothesis.
- To understand the concept of analysis of variance and use it to investigate factorial dependence.

UNIT I ONE-DIMENSIONAL RANDOM VARIABLES 9+3

Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a random variable.

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III ESTIMATION THEORY 9+3

Sampling distributions – Characteristics of good estimators – Method of Moments – Maximum Likelihood Estimation – Interval estimates for mean, variance and proportions.

UNIT IV TESTS OF SIGNIFICANCE 9+3

Type I and Type II errors – Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances – χ^2 test for goodness of fit – Independence of attributes.

UNIT V DESIGN OF EXPERIMENTS 9+3

Completely Randomized Design – Randomized Block Design – Latin Square Design – 2^2 factorial design.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

SUGGESTED LAB EXERCISES

1. Data exploration using R
2. Visualizing Probability distributions graphically
3. Evaluation of correlation coefficient
4. Creating a Linear regression model in R
5. Maximum Likelihood Estimation in R
6. Hypothesis testing in R programming
7. Chi square goodness of fit test in R
8. Design and Analysis of experiments with R

OUTCOMES:

- CO1: Can analyze the performance in terms of probabilities and distributions achieved by the determined solutions.
- CO2: Will be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.
- CO3: Provides an estimate or a range of values for the population parameter from random samples of population.
- CO4: Helps to evaluate the strength of the claim/assumption on a sample data using hypothesis testing.
- CO5: Equips to study the influence of several input variables on the key output variable.

TEXT BOOKS:

1. Irwin Miller and Marylees Miller, "John E. Freund's Mathematical Statistics with applications", Pearson India Education, Asia, 8th Edition, 2014.
2. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K. "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2024.

REFERENCES:

1. Richard A. Johnson, Irwin Miller, John Freund "Miller & Freund's Probability and Statistics for Engineers", Person Education, 8th Edition, 2015.
2. Ross, S.M. "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier, New Delhi, 5th Edition, 2014.
3. Spiegel, M.R., Schiller, J., Srinivasan, R.A. and Goswami, D. "Schaum's Outline of Theory and Problems for Probability and Statistics", McGraw Hill Education, 3rd Edition, Reprint, 2017.
4. Devore, J.L. "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 9th Edition, 2016.

CO – PO Mapping:

COURSE OUTCOMES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

OBJECTIVES

The course aims to learn the principles and applications of heat and mass transfer operations in food industries.

UNIT I HEAT TRANSFER – CONDUCTION**9+12**

Basic heat transfer processes - conductors and insulators - conduction – Fourier’s law of heat conduction – thermal conductivity and thermal resistance - linear heat flow – heat transfer through homogenous wall, composite walls, radial heat flow through cylinders and sphere – solving problems in heat transfer by conduction.

PRACTICALS:

- Determination of overall heat transfer co-efficient for a packed bed heat exchanger.
- Determination of heat transfer co-efficient of double pipe heat exchanger.

UNIT II HEAT TRANSFER – CONVECTION**9+12**

Heat transfer - convection – free and forced convection - factors affecting the heat transfer coefficient in free and forced convection heat transfer – overall heat transfer coefficient - solving problems in foods.

PRACTICALS:

- Determination of economy and thermal efficiency of rotary flash evaporator.
- Determination of molal humidity by using cooling tower.

UNIT III HEAT TRANSFER – RADIATION AND HEAT EXCHANGER**9+12**

Radiation heat transfer – concept of black and grey body - monochromatic Total emissive power– Kirchhoff’s law – Planck’s law - Stefan-Boltzmann’s law –Heat exchangers – parallel, counter and cross flow, design calculations - Logarithmic Mean Temperature Difference – overall coefficient of heat transfer in shell and tube heat exchanger for food products.

PRACTICALS:

- Determination of heat transfer co-efficient using pan dryer.
- Determination of rate of drying using tray dryer.

UNIT IV MASS TRANSFER -DIFFUSION**9+12**

Mass transfer in foods – introduction – Fick’s law for molecular diffusion - molecular diffusion in gases – equimolar counters diffusion in gases and diffusion of A through non diffusing B, diffusion coefficients for gases - molecular diffusion in liquids, solids, biological solutions and gels.

PRACTICALS:

- Performance evaluation of simple distillation.
- Performance evaluation of packing tower.

UNIT V MASS TRANSFER – DISTILLATION**9+12**

Vapour liquid equilibria - Raoult’s law- Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe -Thiele method.

PRACTICALS:

- Performance evaluation of steam distillation.

- Performance evaluation of Bubble cap distillation column.

TOTAL: 105 HOURS (45+60)

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

- CO1** Infer the fundamental concepts of heat conduction.
- CO2** Apply dimensional analysis for solving convective heat transfer.
- CO3** Demonstrate the concept of radiation and to differentiate the heat exchangers
- CO4** Understand the diffusion in gas, liquid, and solids.
- CO5** Analyse the various distillation processes.

TEXTBOOKS

1. Bellaney, P.L. "Thermal Engineering". Khanna Publishers, New Delhi, 2001.
2. Geankoplis C.J. "Transport Process and Unit Operations". Prentice-Hall of India Private Limited, New Delhi, 1999.

REFERENCE BOOKS

1. Jacob and Hawkins. "Elements of Heat Transfer". John Willey and Sons Inc. New York, 1983.
2. Eckert, E.R.G. "Heat and Mass Transfer". McGraw Hill Book Co., New York, 1981.
3. Holman, E.P. "Heat Transfer". McGraw-Hill Publishing Co. New Delhi, 2001.
4. Coulson, J.M. and etal. "Coulson & Richardson's Chemical Engineering", 6th Edition, Vol.I& II, Butterworth – Heinman (an imprint of Elsevier), 2004.
5. McCabe, W.L., J.C. Smith and P.Harriot "Unit Operations of Chemical Engineering", 6th Edition, McGraw Hill, 2003.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	2	2	2	1	2	1	1	3	2	2
CO2	2	2	1	1	3	1	1	2	1	1	1	1	3	2	2
CO3	1	1	1	1	1	1	2	1	2	2	2	2	3	2	3
CO4	2	1	1	2	2	1	1	3	2	1	2	1	3	3	3
CO5	3	1	1	1	1	1	1	1	2	1	1	2	3	2	3
Avg	2	1.2	1	1.6	1.6	1.2	1.4	1.8	1.6	1.4	1.4	1.4	3	2.2	2.6

- 1-low, 2-medium, 3-high, '-' no correlation. The average value of this course to be used for program articulation matrix.

OBJECTIVES

To expose the students to the principles and different methods of food processing and preservation.

UNIT I PRINCIPLES OF MASS AND ENERGY BALANCE**9+12**

Transport phenomena with respect to foods; Factors affecting heat and mass transfer; Study of heat transfer and its application in the design of thermal processes and freezing. Thermal processing; Calculation of process time-temperature schedules.

PRACTICALS

- Heat transfer studies in a plate heat exchanger (parallel and counter flow).
- Refrigeration and freezing of vegetables and fruits.

UNIT II THERMAL METHODS**9+6**

Newer methods of thermal processing; batch and continuous; application of infra-red microwaves; ohmic heating; control of water activity.

PRACTICALS

- Canning & bottling of vegetable and fruit products.

UNIT III DRYING PROCESS FOR FOODS**9+12**

Rate of drying for food products; design parameters of different type of dryers; preservation by concentration and dehydration; properties of air-water mixtures. Psychrometric chart, freezing and cold storage, freeze concentration, freeze drying, IQF; calculation of refrigeration load, design of freezers and cold storages.

PRACTICALS

- Drying of vegetables and fruits with and without additives – Drying rate studies including, constant rate and falling rate periods and the effects of various factors on them.
- Spray drying of juices/milk.

UNIT IV NON-THERMAL METHODS**9+18**

Super critical technology for preservation – chemical preservatives, preservation by ionizing radiations, ultrasonics, high pressure, fermentation, curing, pickling, smoking, membrane technology, osmotic methods. Hurdle technology.

PRACTICALS

- Production of extruded products.
- Filtration and concentration of fruit juices.
- Osmotic drying of foods with salt and sugar.

UNIT V FOOD PACKAGING**9+12**

Basic packaging materials, types of packaging, packaging design, packaging for different types of foods, retort pouch packing, costs of packaging and recycling of materials.

PRACTICALS

- Determination of water-vapor transmission rate of different packaging materials.

- Determination of migration characteristics of packaging materials.

TOTAL: 105 HOURS (45+60)

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

CO1 Understand the principles of food processing and preservation.

CO2 Understand the role of different thermal methods of food preservation and their impact on the shelf life, quality, and other physical and sensory characteristics of foods.

CO3 Familiarize with the recent methods of minimal processing of foods.

CO4 Understand the non-thermal methods of food preservation.

CO5 Understand about various packaging materials suitable for preservation of a specific food.

TEXTBOOKS

1. Sivasankar, B. "Food Processing and Preservation". Prentice Hall of India, 2002.
2. Khetarpaul, Neelam. "Food Processing and Preservation." Daya Publications, 2005.
3. Singh, M.K. "Food Preservation" Discovery Publishing, 2007.
4. Fellows, P.J. "Food Processing Technology: Principles and Practice". 2nd Edition, CRC Wood Head Publishing, 2000.
5. Gopala Rao, Chandra. "Essentials of Food Process Engineering". B.S. Publications, 2006.

REFERENCE BOOKS

1. Rahman, M. Shafiur. "Handbook of Food Preservation". Marcel & Dekker, 2006.
2. Zeuthen, Peter and Bogh-Sarensen, Leif. "Food Preservation Techniques". CRC / Wood Head Publishing, 2003.
3. Ranganna, S. "Handbook of Canning and Aseptic Packaging". Tata McGraw-Hill, 2000.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	3	1	2	1	2	1	2	1	1	3	3	3
CO2	3	2	1	1	2	1	1	2	1	2	1	1	3	2	3
CO3	2	1	1	1	1	2	1	1	2	2	1	2	3	2	3
CO4	2	1	1	2	2	1	1	1	2	1	2	1	3	3	2
CO5	3	1	1	1	1	1	1	1	2	1	1	1	3	3	3
Avg	2.4	1.2	1.2	1.6	1.4	1.4	1	1.4	1.6	1.6	1.2	1.2	3	2.6	2.8

- 1-low, 2-medium, 3-high, '-' no correlation. The average value of this course to be used for program articulation matrix.

OBJECTIVES

The course aims to develop an effective understanding of the composition of food along with the chemical changes of nutrients during food processing and storage.

UNIT I CARBOHYDRATES**9+12**

The principle carbohydrates in the human diet. Occurrence and storage form of carbohydrate in plant and animal foods. Various chemical and physical changes of carbohydrates in food during processing, cooking, and storage -dehydration, hydrolysis, fermentation, caramelization, Maillard reaction, and gelatinization. Changes in carbohydrate content during fruit ripening. Preparation of Glucose syrup, fructose syrup, Sugar alcohols, and Chemistry of Artificial sweeteners. Use of starch in foods, Modified starches, resistant starch, Starch hydrolysates – Maltodextrins and dextrins; Fiber Cellulose & hemicellulose, Pectin's, Gums & seaweeds- gel formation.

PRACTICALS

- Experiment on enzymatic and acid hydrolysis of sucrose
- Experiments to study the gelling properties of starch

UNIT II PROTEINS**9+18**

The principal proteins in the human diet. Review of protein structure & conformation; Various chemical and physical changes of protein in food during processing, and cooking-solubility, hydration, swelling, denaturation, foam formation & stabilization, gel formation, emulsifying effect, thickening & binding, Maillard reaction, denaturation; Interactions of protein with other food components like carbohydrates & lipids and its impact on the functionality, stability, and bioavailability of proteins in food systems. Source of vegan protein and formulation of vegan protein-rich foods. Enzymatic reactions of protein in food, Food enzymes and their role in food spoilage, application of food enzymes; Texturized proteins; Functional role and uses in foods.

PRACTICALS

- Determination of Foaming properties of proteins
- Experimental study of gluten formation using wheat flour
- Determination of iso-electric point of casein & experiment to study the effect of rennin on milk proteins

UNIT III LIPIDS**9+18**

structure, composition and nomenclature of Lipids. Properties of fats & oils, melting points, plasticity, isomerization, Saponification number, iodine value, Reichert-Meissl number, and hydrolysis of triglycerides. Types of fatty acids; Modification of fats hydrogenation- cis and trans isomers, inter- esterification, acetylation, Hydrolytic rancidity & oxidative rancidity; Edible oil refining processes, winterization; Shortening power of fats, tenderization, frying - smoke point, auto-oxidation, polymerization, lipids having emulsifying properties, its application in food industry and detergents; Shortening power of fats, types of fat substitute.

PRACTICALS

- Determination of Solubility, specific gravity, and Refractive index of oils
- Estimation of the free fatty acid content of oil
- Determination of peroxide value and Anisidine value of fats.

UNIT IV CHEMICAL AND NUTRITIONAL CHANGES OF FOOD DURING PROCESSING

9+6

Enzymatic browning of food, Chemical Changes in food during process-alterations of natural pigments, formations of heterocyclic aromatic amines, acrylamide, 5-hydroxymethylfurfural, furan, nitrosamines and acrolein. Stability and loss of Mineral & vitamin content of foods, off- flavors & food taints.

PRACTICALS

- Experiment to study the non-enzymatic and enzymatic browning of foods.

UNIT V AROMA & IMPORTANT PHYTOCHEMICALS IN FOOD

9+6

Naturally occurring colors/pigments in food and impact on antioxidant level, Synthetic food grade Colors, flavor & aroma components present in herbs, spices, coffee, tea, cocoa, fruits, vegetables & fermented products; and naturally similar /artificial flavors, Threshold values. Naturally occurring toxic substances, protease inhibitors, bioactive components phytates, polyphenols, saponins, phytoestrogens, and other compounds.

PRACTICALS

- Study on isolation and properties of saponins from food.

TOTAL: 105 HOURS (45+60)

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

CO1 Understand the structure and properties of carbohydrates.

CO2 Summarize the structure and properties of proteins.

CO3 Review the structure and properties of lipids.

CO4 Analyze the chemical and nutritional changes of food during processing.

CO5 Analyze the phytochemicals in food.

TEXTBOOKS

1. Belitz H.-D, Grosch W and Schieberle P. Food Chemistry, 4th Edition, Springer- Verlag, 2009.
2. Meyer, Lillian Hoagland "Food Chemistry", CBS Publishers, 1987.
3. John M. deMan. "Principles of Food Chemistry", 3rd Edition, Springer, 1999.
4. Chopra, H.K. and P.S. Panesar. "Food Chemistry", Alpha Science International Limited, 2010.

REFERENCE BOOKS

1. Vaclavik, V. A. and Christian E. W. "Essentials of Food Science", 4th Ed., Kluwer Academic, Springer, 2014.
2. Richard Owusu-Apenten "Introduction to Food Chemistry" CRC Press, 2005.
3. Srinivasan Damodaran, Kirk L. Parkin, "Fennema's Food Chemistry ", 5th Ed., CRC Press, 2008.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	2	2	2	1	2	1	1	2	3	1
CO2	3	2	1	1	2	1	1	2	1	1	2	1	2	3	1
CO3	3	2	1	2	1	1	1	1	2	2	1	2	2	3	1
CO4	2	1	1	2	2	1	2	1	2	1	2	1	2	3	1
CO5	2	1	1	3	1	1	2	1	2	1	1	1	2	3	1
Avg	2.4	1.4	1	2.2	1.4	1.2	1.6	1.4	1.6	1.4	1.4	1.2	2	3	1

- 1-low, 2-medium, 3-high, '- '- no correlation. Note: The average value of this course to be used for the program articulation matrix.

COURSE OBJECTIVE:

The objective of the course is four-fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Module I: Introduction**(3L,6P)**

Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration– Its content and process; ‘Natural acceptance’ and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practical Session: Include sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

Module II: Harmony in the Human Being**(3L,6P)**

Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’, Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility, Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer), Understanding the characteristics and activities of ‘I’ and harmony in ‘I’, Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

Practical Session: Include sessions to discuss the role others have played in making material goods available to me. Identifying from one’s own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

Module III: Harmony in the Family and Society**(3L,6P)**

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practical Session: Include sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value

in relationships. Discuss with scenarios. Elicit examples from students' lives

Module IV: Harmony in the Nature and Existence

(3L,6P)

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence.

Practical Session: *Include sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.*

Module V: Implications of Harmony on Professional Ethics

(3L,6P)

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Sum up.

Practical Session: *Include Exercises and Case Studies will be taken up in Sessions E.g. To discuss the conduct as an engineer or scientist etc.*

TOTAL: 45 (15 Lectures + 30 Practicals) PERIODS

COURSE OUTCOME:

By the end of the course, the students will be able to:

1. Become more aware of themselves, and their surroundings (family, society, nature);
2. Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Have better critical ability.
4. Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

REFERENCES:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 3rd revised edition, 2023.
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.

7. Slow is Beautiful - Cecile Andrews.
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj - PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

Web URLs:

1. Class preparations: <https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php>
2. Lecture presentations: https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php
3. Practice and Tutorial Sessions: <https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php>

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						1	1	1	3			3
CO2						1	1	1	3			3
CO3						3	3	2	3		1	3
CO4						3	3	2	3		1	3
CO5						3	3	3	3		2	3

MODULE I – OVERVIEW OF STANDARDS**6**

Basic concepts of standardization; Purpose of Standardization, marking and certification of articles and processes; Importance of standards to industry, policy makers, trade, sustainability and innovation. Objectives, roles and functions of BIS, Bureau of Indian Standards Act, ISO/IEC Directives; WTO Good Practices for Standardization. Important Indian and International Standards.

MODULE II – FOOD STANDARDS**9**

Quality grading and certification, Agmark standards, FSSAI standards, Quality council of India, Codex standards, Permitted food additives; HS Code; Food Category Code; contaminants, pesticide residues, metallic contaminant, product-specific quality standards; licensing and imports related requirements, Approval for Non-Specified Food and Food Ingredients, Food Product Approval System” (FPAS), vertical and horizontal standards, Food Safety Auditing.

TOTAL: 15 HOURS**TEXTBOOKS / REFERENCE BOOKS:**

1. Lasztity R., Food Quality and Standards, EOLSS Publishers, United Kingdom, 2009.
2. Gupta R.K., Dudeja P., Minhas A.S., Food Safety in the 21st Century Public Health Perspective, Elsevier, United Kingdom, 2017.
3. FAO and WHO, 2020. The Future of Food Safety – Transforming Knowledge into Action for People, Economies and the Environment. Technical Summary by FAO and WHO. Rome.
<https://doi.org/10.4060/ca8386en>

OBJECTIVES:

To gain foundational knowledge, practical applications, and market considerations to provide a comprehensive understanding of sustainable food product development.

UNIT I INTRODUCTION TO SUSTAINABLE FOOD SYSTEMS 9

Overview of Sustainability in Food Production - Definitions, principles, and importance; Environmental Impacts of Conventional Food Systems - Resource use, pollution, and waste; Sustainable Food Systems Framework - Key concepts and strategies for sustainability.

UNIT II SUSTAINABLE INGREDIENTS AND SOURCING 9

Sustainable Agriculture Practices - Organic farming, permaculture, and regenerative agriculture; Ethical Sourcing - Fair trade, local sourcing, and reducing food miles; Alternative Ingredients - Plant-based proteins, insect proteins, and innovative materials.

UNIT III SUSTAINABLE FOOD PRODUCT DESIGN 9

Design Principles for Sustainable Products - Lifecycle assessment, eco-design, and minimalism; Formulation and Development - Balancing taste, nutrition, and environmental impact; Packaging Innovations - Sustainable packaging materials and techniques.

UNIT IV CONSUMER TRENDS AND MARKET ANALYSIS 9

Consumer Preferences and Behavior - Trends in sustainable food consumption, Market Analysis - Identifying target markets, understanding consumer demand, and market positioning; Case Studies - Successful examples of sustainable food products and companies.

UNIT V IMPLEMENTATION AND EVALUATION 9

Regulatory and Certification Standards - Organic, Fair Trade, and other certifications; Sustainability Metrics and Evaluation - Measuring and reporting sustainability performance; Product Launch and Marketing Strategies - Effective strategies for introducing and promoting sustainable food products.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

CO1: Comprehend Sustainability Concepts

CO2: Analyze and Select Sustainable Ingredients

CO3: Design Sustainable Food Products

CO4: Evaluate Market Dynamics

CO5: Implement and Assess Sustainable Practices

TEXTBOOKS:

1. Ronald J. W. L. Davis, Patrick D. H. Lee, Sustainable Food Systems: A Global Life Cycle Perspective, Academic Press, 2020.
2. Nick Hurd, The Future of Food: How Digital Technology Will Transform the Food Industry, CRC Press, 2021.
3. Janice M. Thompson, Judy A. Harrison, Food Product Design: An Integrated Approach, Wiley-Blackwell, 2019.
4. Heather R. Faulkner, Consumer Behavior in Food and Nutrition: Understanding the Sustainable Food Market, Routledge, 2022.

SEMESTER – V

FT23501

FOOD REFRIGERATION AND COLD CHAIN

L T P C

3 0 0 3

OBJECTIVES

The course aims to study the principles of cooling, air conditioning and freezing and achieve effective and efficient food refrigeration design solutions.

UNIT I REFRIGERATION PRINCIPLES AND REFRIGERANTS

9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P– Desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical. Cryogenics, application of cryogenics in food. Production of low temperatures Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization. Chloroflouro Carbon (CFC) refrigerants - effect on environmental pollution - alternate refrigerants - application of refrigeration.

UNIT II VAPOUR REFRIGERATION SYSTEM

9

Vapour compression cycle p-h and T-s diagrams - deviations from theoretical cycle - sub-cooling and super heating- effects of condenser and evaporator pressure on COP- multi-pressure system - low temperature refrigeration - Cascade systems – problems. Vapour-absorption refrigeration system vapour absorption cycle – theoretical - deviation in practice - Electrolux refrigerator – construction and principles. Equipment Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III FOOD FREEZING

9

Freezing-Freezing curve for Homogenous and Non- homogenous food system, Freezing point depression, Freezing rate, freezing time estimation, Effect of freezing Physical and chemical changes in Foods, Enzyme activity, Microbe inactivation and Food quality sensory quality, nutritional aspects, freeze drying and freeze concentration.

UNIT IV COLD STORAGE

9

Food Cooling and Precooling, Cool and Cold Storage – types, design of cold storage, CAS, Respiration (Heat Generation), Transpiration (Moisture Loss), Cooling Process Parameters – Analysis– estimation of cooling time. Cooling load estimation and psychrometric analysis.

UNIT V COLD CHAIN

9

Introduction, need for the chain for chilled / frozen food item, various links of the chain; importance of shelf- life; just – in-time deliveries; Refrigerated transport Handling and distribution, cold chain, refrigerated product handling, refrigerated vans, refrigerated display. Challenges in international food supply chain – managing challenges; Trends in supply chain relationships; PPP and TTT concepts; Temperature monitoring; -Critical temperatures; Temperature –time indicators (TTI); Thaw indicators.

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

At the end of the course the students will be able to

CO1 understand the basic concepts of refrigeration and explain on refrigerants.

CO2 describe and demonstrate on principle, components and working of vaporrefrigeration systems.

CO3 Learn the food freezing principles and estimate freezing rate and time

CO4 design coldstorage for food products and estimate cooling load

CO5 Summarize the cold chain management and assess use of TTI and its recent trends.

TEXTBOOKS

1. Arora, C.P., Refrigeration and Air Conditioning, McGraw Hill, 3rd ed, New Delhi,2012.
2. Khurmi, R. S.. Textbook of Refrigeration and Air Conditioning. 5th edition, S. Chand Limited, 2020.
3. Hundy, G F. Refrigeration, Air Conditioning and Heat Pumps. 5TH edition: Elsevier Science, 2016.
4. Sapali S. N.. REFRIGERATION AND AIR CONDITIONING. 2ND edition, PHI Learning, 2018.

REFERENCE BOOKS

1. Roy J. Dossat, Principles of Refrigeration, Pearson Education Asia, 4th Edition,2009.
2. Stoecker, W.F. and Jones J. W., Refrigeration and Air Conditioning, McGrawHill, NewDelhi, 1986.
3. ASHRAE Hand book Refrigeration, Fundamentals 2010 by American Society of Heating,Refrigerating and Air-Conditioning Engineers
4. Sun, Da-Wen. “Advances in Food Refrigeration”. Leatherhead Publishing, 2001.
5. Kennedy, Christopher J. “Managing Frozen Foods”. CRC /WoodheadPublishing,2000

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	2	2	1	1	-	2	-	-	2	3	2	3
CO2	3	2	2	3	3	1	1	-	1	-	1	2	3	2	3
CO3	3	2	3	2	1	-	1	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	2	2	-	3	-	1	3	3	3	3
CO5	2	3	3	3	3	1	1	-	3	-	1	3	3	3	3
Avg	2.80	2.20	2.60	2.60	2.40	1.25	1.20	-	2.25	-	1.00	2.60	3.00	2.60	3.00

- 1-low, 2-medium, 3-high, '-no correction. Note: The average value of this course is to be used for the program articulation matrix.

OBJECTIVES

The course aims to expose the students to the principles, methods, and techniques of food analysis.

UNIT I SAMPLING METHODS AND SPECTROSCOPIC TECHNIQUES**9+12**

Food regulations and standards - sampling methods - sample preparation and preservation- extraction methods and separation of food components; statistical evaluation of analytical data - official methods of food analysis. proximate analysis of foods-moisture in foods, ash content of foods - determination by different methods; titratable acidity in foods, determination of dietary fibre and crude fibre Spectrophotometry - basic principles, spectrophotometric analysis of food additives and food components - IR spectroscopy in online determination of components in foods; AAS and ICP AES in mineral elements and toxic metals analysis.

PRACTICALS

- To analyse texture of solid and semi-solid food products.
- To determine ferrous iron content in foods by UV spectrophotometry.

UNIT II LIPIDS AND PROTEINS ANALYSIS**9+12**

Determination of total fat in foods by different methods; analysis of oils and fats for physical and chemical parameters, quality standards, and adulterants. Determination of proteins concentration- colorimetric methods, determination of total nitrogen, spectrophotometric determination; protein characterization- electrophoresis and isoelectric focusing; analysis of protein quality - Protein Efficiency Ratio (PER), Net Protein Utilization (NPU), biological value, protein digestibility- corrected amino acid score (PDCAAS), In vitro Protein digestibility for C-PER; measurement of functional properties of proteins- protein hydration properties, surface properties of protein, protein gel properties.

PRACTICALS

- To analyse viscosity of liquid food product.
- To identify adulterants in cereals, spices & condiments, fat, and oil.

UNIT III CARBOHYDRATE ANALYSIS, REFRACTOMETRY AND POLARIMETRY**9+12**

Refractometry - basic principles and instrumentation, and applications - brix value of fruit juices, total soluble solids in fruit products, carbohydrate analysis - colorimetric quantification methods of mono- and di-saccharides, HPLC of mono- and di-saccharides using refractive index detection; starch- enzymatic quantification and determination of total amylose content; cell wall polysaccharides - determination of uronic acid content and β -glucan content, degree of methylation and acetylation of pectin, polarimetry - basic principles, instrumentation, and applications - determination of specific rotations of sugars; estimation of simple sugars and disaccharides.

PRACTICALS

- To estimate antioxidant activity in foods by DPPH assay.
- To identify sugars in fruit juice using TLC.

UNIT IV CHROMATOGRAPHIC TECHNIQUES**9+12**

Chromatography - basic principles, detection of adulterants in foods by paper chromatography and thin layer chromatography, column chromatography for purification of pigments, analysis of food additives, phytochemicals

and aflatoxins, contaminants and other food components by HPLC, GC analysis of fatty acids, cis, trans isomers - volatile oil, flavours and pesticides, contaminants and other volatile derivatives of food components; significance MS detector in HPLC and GC; ion exchange chromatography for amino acid purification, affinity chromatography for protein purification.

PRACTICALS

- To determine vitamin C in fruit juices:
 - Titrimetric method using dichlorophenolindophenol dye.
 - Spectrophotometric using dinitrophenylhydrazine or HPLC method.
- To evaluate column chromatographic separation of carotenoids.

UNIT V SENSORY EVALUATION TECHNIQUES

9+12

Introduction to quality attributes of food appearance, flavour, textural factors and additional quality factors; gustation importance of gustation, mechanism of taste perception, chemical dimensions of basic tastes- sweet, salt, sour, bitter and umami, taste measurement-electronic tongue; olfaction definition and importance of odour and flavour, mechanism of odour perception, theories of odour classification, chemical specificity of odour, odour, measurement technique- e- nose; colour importance of colour, dimensions of colour and attributes of colour and gloss, perception of colour, colour measurement; texture definition and importance of texture, phases of oral processing, texture perception, rheology of foods, texture classification, texture measurement and recent advances in texture evaluation, sensory evaluation objectives, type of food panels, characteristics of panel member, layout of sensory evaluation laboratory, sensitivity tests, threshold value, paired comparison test, duo trio test, triangle test, hedonic scale.

PRACTICALS

- Isolation and identification of synthetic food colour in sweets, confectioneries, and beverages.
- Determination of iodine content in iodized salt.

TOTAL: 105 HOURS (45+60)

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

CO1 Understand the sampling methods and spectrophotometric techniques in food analysis.

CO2 Identify the methods of assessment and characterization of lipids and proteins in food samples.

CO3 Understand the importance of refractometry and polarimetry in carbohydrates.

CO4 Use the chromatographic principles to separate and analyze materials.

CO5 Perform the sensory evaluation of foods.

TEXTBOOKS

1. Pomeranz, Yeshajahu. "Food Analysis Theory and Practice". 3rd Edition. Aspen Publishers / Springer, 2000.
2. Kirk, R.S. and R. Sawyer "Pearson's Composition and Analysis of Food". 9th Edition. Longman, New York, 1991.
3. Nielsen, S. Suzanne. "Food Analysis". 4th Edition. Springer, 2010.

REFERENCE BOOKS

1. Ronald E. Wrolstad. "Handbook of Food Analytical Chemistry" Vol I, John Wiley & Sons, 2005
2. Magdi M. Mossoba. "Spectral Methods in Food analysis" Marcel & Dekker, 1998.
3. Otlés, Semih. "Methods of Analysis of Food Components and Additives". CRC Press, 2005.
4. Nollet, Leo M.L. "Hand Book of Food Analysis" II Rev. Edition. Vol. I, II & III, Marcel & Dekker, 2004.
5. Nollet, Leo M.L. "Food Analysis by HPLC". II Rev. Edition, Marcel & Dekker, 2000.
6. Otlés, Semih. "Handbook of Food Analysis Instruments". CRC Press, 2009.

7. Meilgard. "Sensory Evaluation Techniques", 3rd Ed., CRC Press LLC, 1999.
 8. Maynard A. Amerine, Rose Marie Pangborn, Edward B. Roessler. "Principles of Sensory Evaluation of Food", Academic Press, 2013.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	3	3	1	1	1	1	1	1	2	3	3	3
CO2	1	3	3	3	3	1	1	2	1	2	1	2	3	3	2
CO3	2	3	3	3	3	1	1	2	1	2	1	2	3	3	2
CO4	2	3	3	3	3	2	1	1	1	1	2	2	3	3	2
CO5	2	3	3	3	3	1	2	1	1	1	1	2	3	3	3
Avg	1.8	2.8	3	3	3	1.2	1.2	1.4	1	1.4	1.2	2	3	3	2.4

- 1-low, 2-medium, 3-high, '-' no correlation. The average value of this course to be used for program articulation matrix.

OBJECTIVES

To understand the engineering properties of food, various unit operations and non-thermal technologies involved in food processing.

UNIT I PROPERTIES OF FOOD**9**

Engineering properties of food materials - rheological and textural properties, thermal properties, thermodynamic properties, surface & gas exchange properties, electric and dielectric properties; water activity, water sorption isotherms, hysteresis, theories of sorption hysteresis, water activity measurement methods, water binding, control of water activity and moisture, principles of IMF and their application.

UNIT II SEDIMENTATION AND CENTRIFUGATION**9**

The velocity of particles moving in a fluid - terminal velocity - drag coefficient terminal velocity magnitude, sedimentation - sedimentation equipment, flotation, sedimentation of particles in a gas settling under combined forces cyclones - optimum shape, efficiency impingement, separators, classifiers, centrifugal separations - centrifugal force particle velocity, liquid separation, radial variation of pressure radius of neutral zone, centrifuge equipment.

UNIT III REACTION KINETICS**9**

Basic chemical kinetics, concept of rate-limiting step, basic chemical kinetics, order of reaction, first-order rate processes, determining kinetic parameters - Differential methods, Integral methods, accuracy of rate constants, temperature dependence of reaction kinetics - Arrhenius model, Thermal death time model, Q10 model, Kinetic parameter values important in food processing, Enzyme-catalyzed reactions. Food shelf life - factors, shelf-life testing methods, ASLT.

UNIT IV THERMAL PROCESSING**9**

Drying - equipment, dryer efficiencies, drying kinetics; osmotic dehydration – mechanism, effect of process parameters on mass transfer; principles of thermal processing, heat transfer in thermal processing, characterization of heat penetration data, retort come-up time, kinetics of thermal inactivation of microorganisms and enzymes, concept of thermos-bacteriology, temperature dependence reaction rates, heat transfer considerations in thermal processing - in-package, in-Flow; extrusion - hot & cold extrusion, single- and twin-screw extrusion – low-pressure and high-pressure extrusion - properties of food materials and its significance in equipment design - processing and handling application in food industry; baking principles - baked foods, baking equipment; roasting principles of roasting, roasting equipment.

UNIT V NON-THERMAL PROCESSING**9**

Ohmic heating, radiation preservation of foods, high-pressure processing, microwave and dielectric & infrared heating, high-intensity pulsed electric fields (PEF), ultraviolet light, ultrasonics, oscillating magnetic fields (OMF), physical parameters, equipment and application, hurdle technology.

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

CO1 Understand and apply the basic engineering properties of foods in food production.

CO2 Understand the concept of separation and sedimentation.

CO3 Apply the reaction kinetics concepts in food production.

CO4 Design parameters for thermal processing of food.

CO5 Recognize various non-thermal unit operations in food production.

TEXTBOOKS

1. Toledo, Romeo T. "Fundamentals of Food Process Engineering" 2nd Edition, CBS Publishers, 2012.
2. Maroulis, Zacharias B., and Saravacos, George D. Food Process Engineering Operations, CRC Press, 2011.
3. Smith P.G "Introduction to Food Process Engineering". 2nd Edition, Springer, 2011.
4. Earle, R.L, "Unit Operations in Food Processing". Pergamon Press. Oxford. UK, 2013.

REFERENCE BOOKS

1. Sahay, K.M., and K.K. Singh. "Unit Operation of Agricultural Processing", Vikas Publishing House Pvt. Ltd., New Delhi, 2004.
2. Berk, Zeki. "Food Process Engineering and Technology". Elsevier, 2009.
3. Leniger, H.A., and Beverloo, W.A. Food Process Engineering. Netherlands, Springer Netherlands, 2012.
4. Fellows, P.J. "Food Processing Technology Principles and Practice". 3rd Edition, Woodhead Publisher, 2009.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1	1	2	3	3	2	1	2	3	3	3
CO2	1	2	1	1	1	1	1	2	1	2	2	1	1	2	2
CO3	1	2	1	1	1	1	1	1	3	3	1	2	3	2	3
CO4	2	3	2	2	2	2	3	2	3	2	1	1	3	3	3
CO5	3	2	1	1	2	1	1	1	2	3	2	1	3	3	3
Avg	1.8	2	1.4	1.2	1.4	1.2	1.6	1.8	2.4	2.4	1.4	1.4	2.6	2.6	2.8

- 1-low, 2-medium, 3-high, '-' no correlation. The average value of this course to be used for program articulation matrix.

OBJECTIVES:

To acquaint the students with the concepts of informatics databases and models.

UNIT I INTRODUCTION 9

Role of functional foods against metabolic syndrome like diabetics, celiac diseases. Potential benefits (like antioxidant, anticancer activity) of active compounds present in the food materials (herbs, fruits, & vegetables) – proteins and phytochemicals like – Carotenoids, Lycopene, Xanthophylls, lutein, Sulfides, Polyphenolics, Flavonoids, Naringin, Quercetin, Anthocyanidins, catechins, Flavones, Prebiotics / Probiotics, Fructo oligosaccharides, Lactobacillus, Phyto estrogens: Isoflavones, daidzein, Geebustin, lignans, Tocopherols, etc.

UNIT II SEQUENCE DATABASE 9

Introduction to bioinformatics tools: Sequence database – Nucleotide, protein, Literature Databases, Composite Databases (NRDB), Genome Databases- (Viral genome database (ICTV db)), Bacterial Genome database (GOLD, MGD), Organism specific database. file formats, Introduction to sequence alignment (only general ideas, not algorithm) – Local and global, pair wise and multiple, BLAST. Small compound database

UNIT III ONLINE TOOLS 9

PubChem, ChemSpider, ZINC, ChEMBI, Drug Bank, Flavornet (Volatile compounds from the literature based on GC-MS), SuperSweet (Database – Carbohydrates & artificial sweeteners).

UNIT IV IN SILICO Models 9

Introduction to Molecular docking, Structure Based methods to identify lead components, Energy minimization tool, Denovo ligand design, molecular docking and molecular simulation case studies.

UNIT V INVITRO Models 9

Introduction – preparation of cell culture media and its requirements. Preservation cell line cultures – cryopreservation. Facts of cell line contamination; cell line studies: Anti-diabetic, Anti-Cancer, and Anti-inflammation activity. cytotoxicity by MTS assay. Case studies.

TOTAL: 45 PERIODS**OUTCOMES:**

- CO 1 : Understand the active compounds in food products.
 CO 2 : Apply bioinformatics tools to understand the functions of the compounds.
 CO 3 : Use different online tools to understand the properties of the food components.
 CO 4 : Understand *insilico* models and molecular simulation.
 CO 5: Familiarize with cell culture studies.

TEXT BOOKS:

1. Karina M.M. and José L.M.F. Food Informatics – Applications of Chemical Information to Food Chemistry. Springer, Switzerland, 2014.

2. Dash, S., Acharya, B. R., Mittal, M., Abraham, A., & Kelemen, A. (Eds.). Deep learning techniques for biomedical and health informatics. Cham, Switzerland: Springer International Publishing, 2020.
3. Choudhury A., Biswas A., Prateek M., Chakrabarti A, Agricultural Informatics. Scrivener Publishing LLC, 2021.

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS**9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

UNIT II INTRODUCTION TO PROJECT MANAGEMENT**9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS**9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL**9**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT**9**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve

TOTAL: 45 PERIODS**COURSE OUTCOMES(COs):**

Upon successful completion of the course, students should be able to:

CO1: Understand the costing concepts and their role in decision making.

CO2: Understand the project management concepts and their various aspects in selection.

CO3: Interpret costing concepts with project execution.

CO4: Gain knowledge of costing techniques in service sector and various budgetary control techniques.

CO5: Become familiar with quantitative techniques in cost management.

TEXT BOOKS:

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.
2. Albert Lester, Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

OBJECTIVE

The course aims to provide students a foundation about food omics technologies and its applications.

UNIT I INTRODUCTION TO FOODOMICS**9**

Types of omics measurements – genomics, transcriptomics, proteomics, metabolomics. Omics subdisciplines – epigenomics, lipidomics, interactomics, metallomics, diseasomics.

UNIT II FOOD DATABASES**9**

Nutrient composition of food, procedures for data collection, procedures for data entry into foodomics database, precision ketogenic therapy, diet prescription for patients.

UNIT III FOODOMICS TECHNOLOGIES**9**

Multivariate data analysis, infrared (IR) spectroscopy, biomarkers, food quality attributes, metabolite identification, chemometrics, data mining, machine learning, applications in health studies.

UNIT IV CHARACTERIZATION OF FOODS**9**

Structure of food, ultra-processed foods (UPFs), epidemiological studies, food intake biomarkers, clinical parameters, health status, nutrient bioaccessibility and bioavailability.

UNIT V MODERN APPLICATIONS FOR FOODOMICS**9**

Food production chain, global food distribution, bioactive role of foods, PCR testing and DNA sequencing, food profiling, food fingerprinting, genetic lines, authentication, and traceability of foods.

TOTAL: 45 HOURS**COURSE OUTCOMES:**

CO1 To obtain knowledge on food omics technologies.

CO2 To evaluate and predict ways in which complex interactions of components of the food system influences human health and nutrition.

CO3 To assess food biomarkers and targets.

CO4 To describe the characterization of foods.

CO5 To understand the applications of foodomics

TEXTBOOKS

1. Jorge B.V., Foodomics – Omic Strategies and Applications in Food Science. Royal Society of Chemistry, 2021.
2. Cifuentes A., Comprehensive Foodomics. United States: Elsevier Science, 2020.
3. Cifuentes A., Foodomics: Advanced Mass Spectrometry in Modern Food Science and Nutrition. United States: Wiley, 2013.

OBJECTIVES

To equip students with a comprehensive understanding of food business management and entrepreneurship, focusing on identifying opportunities, developing strategic plans, managing operations, navigating legal frameworks, and leveraging emerging technologies and trends.

UNIT I INTRODUCTION TO FOOD BUSINESS MANAGEMENT AND ENTREPRENEURSHIP 9

Overview of the Food Industry, Global food industry trends, Indian and Tamil Nadu food industry landscape, Entrepreneurship Fundamentals, Characteristics of successful food entrepreneurs, Identifying opportunities in the food sector, Business Models in Food Industry: Traditional vs. modern business models. Case Study: Impossible Foods (Plant-based meat substitutes), Amul (Dairy cooperative model), Aachi Masala (Traditional spice blends). Patents and Intellectual Property, Introduction to patents and IP rights in the food industry, Process of obtaining a patent for food products.

UNIT II BUSINESS PLANNING AND STRATEGY 9

Business Plan Development, Components of a business plan, Market analysis and competitive strategy; Financial Planning and Management, Funding sources and financial projections, Budgeting and cost management, Marketing and Sales Strategies, Branding, positioning, and market entry strategies, Digital marketing and e-commerce for food businesses. Case Study: Ben & Jerry's (Branding and social responsibility), Haldiram's (Expansion and diversification), CavinKare (Innovative marketing in personal and food care)

UNIT III OPERATIONS AND SUPPLY CHAIN MANAGEMENT 9

Food Production and Operations Management, Process optimization and quality control, Facility management, and automation; Supply Chain and Logistics, Managing suppliers and inventory, Cold chain logistics and distribution; Sustainability and Ethical Practices, Sustainable sourcing and eco-friendly practices, Corporate social responsibility in food businesses. Case Study: Nestlé (Supply chain sustainability), ITC Foods (Integrated agribusiness model), Suguna Foods (Poultry integration model).

UNIT IV LEGAL, REGULATORY, AND COMPLIANCE 9

Food Safety and Quality Regulations, Global food safety standards (e.g., FDA, EFSA), Indian food safety standards (FSSAI), Regulatory Compliance and Certification, HACCP, ISO 22000, and other certifications; Labeling and Packaging Regulations, Nutritional labeling requirements, Eco-friendly and smart packaging innovations; Legal Challenges and Dispute Resolution, Intellectual property disputes in the food industry. Case Study: Monsanto (GMO patents and legal battles), PepsiCo vs. Indian Farmers (Potato patent case), Ambika Appalam (Trademark dispute)

UNIT V INNOVATION AND FUTURE TRENDS 9

Emerging Technologies in the Food Industry, Biotechnology, AI, and IoT applications in food production, Trends in alternative proteins and functional foods; Consumer Behavior and Market Research, Understanding consumer preferences and trends, Techniques for market research and product testing; Innovation and New

Product Development, Ideation to commercialization process, Lean startup methodology for food entrepreneurs; Scaling and Global Expansion, Strategies for scaling food businesses internationally. Challenges and opportunities in global markets. Case study: Beyond Meat (Scaling plant-based products globally), Chitale Bandhu (Adopting modern tech in traditional sweets), Milky Mist (Dairy innovation and expansion). Role of R&D in innovation and patenting. Case studies of successful food patents driving business growth.

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

CO1: Understand the global and Indian food industry landscape and business models.

CO2: Develop and execute detailed business plans, including market analysis and financial planning.

CO3: Manage operations and supply chains focusing on optimization, quality control, and sustainability.

CO4: Navigate the food industry's legal and regulatory requirements, including safety standards and intellectual property.

CO5: Explore and apply emerging technologies and trends to innovate and grow food businesses

TEXTBOOKS

1. "Food and Beverage Management" by John Cousins, David Foskett, and Caillein Gillespie
2. "Food Industry Management: Principles and Case Studies" by William P. Jennings, Fred W. Krum, and Allen F. Wysocki
3. "Entrepreneurship in the Food Sector: Sustainability, Innovation, and Technology" edited by Peter M. Scholliers and Vicente Pinilla
4. "The Food Business Toolkit: How to Succeed as a Food Entrepreneur" by Richard Myrick
5. "Food Product Development: From Concept to the Marketplace" edited by I. Sam Saguy and Ernest M. Graf.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	2	3	3	2	3	2	1	2	2	2
CO2	2	3	2	1	3	2	1	2	3	2	2	2	3	3	2
CO3	2	2	3	1	2	3	2	2	2	3	1	2	2	3	2
CO4	2	2	2	1	2	3	2	2	2	2	3	1	2	2	3
CO5	3	1	3	1	2	2	1	2	2	1	2	2	3	3	2
Avg	2.4	2	2.2	1	2.2	2.4	1.8	2.2	2.2	2.2	2	1.6	2.4	2.6	2.2

- 1-low, 2-medium, 3-high, '-' - no correlation. Note: The average value of this course is to be used for the program articulation matrix.

OBJECTIVES

The course aims to understand the process development and design consideration of food plant layout, understand the quantitative analysis of cost estimation and practical consideration of food plant layout.

UNIT I OVERALL DESIGN OF AN ENTERPRISE**10**

Plant design, sales planning for plant design. Plant Location, levels of Plant location. Location of layout location factors, plant site selection. Location theory and models, industrial buildings and grounds. Classification of Dairy and Food Plants, farm level collection and Chilling centre. Space requirement.

UNIT II PREPARATION OF A PLANT LAYOUT**10**

Plant Layout problem, importance, objectives, classical types of layouts. Evaluation of Plant layout. Advantages of good layout. Organizing for Plant Layout, Data forms. Development of the pilot layout, constructing the detailed layout Functional design, Siting of different sections in a plant, Layout installations.

UNIT III DEVELOPMENT AND PRESENTATION OF LAYOUT**10**

Engineering economy, Linear programming, Queuing theory, Common Problems in Plant Layout and Process scheduling, Siting of Process sections, Equipment selection and capacity determination, Arrangement of process, and service equipment, Estimation of Services and Utilities, Office layout, line balancing, Flexibility. Practical layouts Common materials of construction of Food plant, building. Maintenance of Food Plant Building, Illumination and ventilation, Cleaning & sanitization, painting and colour coding, Fly and insect control.

TOTAL: 30 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO 1 Design and set-up a new food processing plant as entrepreneur and/or consultant.

CO 2 Understand the food industry losses and maximize the processed food production.

CO 3 Prepare cost estimate and economic analysis of a food industry.

TEXT BOOKS:

1. M Moore, Mac Millan, "Plant Layout & Design". Lames, New York, 1971.
2. H.S. Hall & Y.S. Rosen, "Milk Plant Layout". FAO Publication, Rome, 1963.
3. Antonio Lopez-Gomez, Gustavo V. Barbosa-Canovas, "Food Plant Design (Food Science and Technology)", CRC Press, 2005.

REFERENCES:

1. "Food plant engineering system" by Theunis C. Robberts, II Edition, CRC Press, Washington, 2013.
2. "Food plant economic" by Zacharias B. Maroulis and George D. Saravacos published by Taylor and Francis Group, LLC, 2008
3. John Holah, HuubLelieveld, "Hygienic Design of Food Factories", Woodhead Publishing, 2011.
4. Slade, S. "Food Processing Plant" Vol. 1, Leonard Hill Books, 1990.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	3	2	3	3	1	3	2	3	3	1
CO2	2	3	2	3	3	1	2	1	3	1	3	2	3	3	2
CO3	2	3	2	3	2	3	1	3	3	1	3	2	3	3	2
Avg	2.3	3	2.3	2.6	2.6	2.3	1.6	2.3	3	1	3	2	3	3	1.6

- 1-low, 2-medium, 3-high, '-' no correlation. The average value to be used for program articulation matrix.

OBJECTIVES:

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature, and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

UNIT I INTRODUCTION AND SIGNIFICANCE**9**

Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoo chemicals and microbes in food, plants, animals, and microbes.

UNIT II ANALYSIS OF PHYTOCHEMICALS**9**

Qualitative and quantitative methods: phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, Chitin; Carotenoids - Factors affecting bioavailability, chemical and histochemical characterization of cell wall polysaccharides in almond seed in-relation to lipid bioavailability.

UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY**9**

In vitro and In vivo methods for the assessment of antioxidant activity, Comparison of different In Vitro methods to evaluate the antioxidant, Prediction of the antioxidant activity of natural phenolics from electro-topological state indices, Optimising phytochemical release by process technology, Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

UNIT IV ROLE IN HEALTH AND DISEASE**9**

Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV, and Dental disease; Importance and function of probiotic, prebiotic, and symbiotic and their applications, Functional foods, and immune competence; role and use in obesity and nervous system disorders.

UNIT V SAFETY ISSUES**9**

Health Claims, regulations, and safety issues – International and national.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO1 Understand the basics of nutraceuticals and phytochemicals

CO2 Analyse the soluble component of food products using qualitative and quantitative methods

CO3 Evaluate the methods used to assess the activity of antioxidants

CO4 Apply and analyze the role of Nutraceuticals and Functional foods in health aspects

CO5 Apply the suitable food safety regulations in the food industry sector for getting healthy food

TEXTBOOKS

1. Bisset, Normal Grainger and Max Wich H "Herbal Drugs and Phytopharmaceuticals", II Edition, CRC, 2001.
2. Wildman, Robert "Handbook of Nutraceuticals and Functional Foods". CRC, 2006.
3. Webb, P P. "Dietary Supplements and Functional Foods". Blackwell, 2006.
4. Ikan, Raphael "Natural Products: A Laboratory Guide", 2nd Edition, Academic Press / Elsevier, 2005.
5. Tipnis, H.P. "Bioavailability and Bioequivalence: An Update" New Age International.

REFERENCES

1. Shi, John, FereidoonShahidi and Chi-Tang Ho "Asian Functional Foods". CRC / Taylor & Francis, 2007.
2. Watson, Robald Ross "Functional Foods and Nutraceuticals in Cancer Prevention". Blackwell Publishing, 2007.
3. Gibson, G.R. and C.M.Willams. "Functional Foods : Concept to Product". Woodhead, 2000.
4. Hanson, James R. "Natural Products: The Secondary Metabolites", Royal Society of Chemistry, 2003.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	2	2	2	1	2	1	1	2	3	1
CO2	3	2	1	1	2	1	1	2	1	1	2	1	2	3	1
CO3	3	2	1	2	1	1	1	1	2	2	1	2	2	3	1
CO4	2	1	1	2	2	1	2	1	2	1	2	1	2	3	1
CO5	2	1	1	3	1	1	2	1	2	1	1	1	2	3	1
Avg	2.4	1.4	1	2.2	1.4	1.2	1.6	1.4	1.6	1.4	1.4	1.2	2	3	1

- 1-low, 2-medium, 3-high, '-' - no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

To educate students on systems for food safety surveillance and create awareness on the regulatory and statutory bodies in India and the world.

UNIT I INTRODUCTION TO FOOD SAFETY AND QUALITY ASSURANCE**9**

Definition of food safety and concept of safe food; characterization of food hazards - physical, chemical, and biological; Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants); HACCP, HACCP Prerequisites and Good Hygienic Practices; Principles and Implementation of HACCP, Risk analysis - Risk Assessment, Risk management, Risk Communication, Food Safety Management Systems.

UNIT II INDIAN FOOD REGULATORY REGIME**9**

Origin of Food Safety in India, Food Safety and Standards Act, Food Safety and Standards Rules, 2011, Overview of Food Safety and Standards Regulations, Structure and Functions of Food Authority, Overview of systems and processes in Standards, Enforcement, Laboratory ecosystem, Imports, Third Party Audit etc., Promoting safe and wholesome Food (Eat Right India, Food Fortification, SNF, Clean Street Food Hub, RUCO and various other social and behavioral change initiatives), Training and capacity building etc., Digital Governance systems of FSSAI – FoSCoS, FICS, Hygiene rating etc.

UNIT III GLOBAL SCENARIO**9**

Codex Alimentarius Commission - History, Members, Standard setting, and Advisory mechanisms: JECFA, JEMRA, JMPR, Role of International Bodies in standard setting process, International Organization for Standardization (ISO), World Organization for Animal health, International Plant Protection Convention (IPPC), WTO-SPS-TBT agreements and its implications, European Food Standards Authority (EFSA), Food Safety Australia and New-Zealand (FSANZ), USFDA etc.

UNIT IV EXPORT AND IMPORT REGULATING AUTHORITIES**9**

Export regulations and promotion bodies; Export (Quality control and inspection) act, APEDA, MPEDA, Spice board, Coffee Board etc, Role of DGFT, Export Inspection Agency, Plant and Animal Quarantine, Customs Act and Import Control Regulations.

UNIT V OTHER BODIES/LAWS GOVERNING FOOD SAFETY**9**

Bureau of Indian Standards, AGMARK, Advertising Standards, Overview of acts governing Food Safety in specific areas: - legal Metrology act, Consumer protection act, Environmental Waste management rules with respect to packaging, Infant Milk Substitute act, etc.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO1 Understand and analyse various aspects of food safety and quality assurance.

CO2 Understand regulatory and statutory bodies in India.

CO3 Understand, asses and apply the knowledge of global food safety scenario.

CO4 Understand export and import regulatory authorities.

CO5 Understand the laws that govern food safety standards.

TEXTBOOKS

1. Alli, Inteaz. Food Quality Assurance: Principles and Practices. United Kingdom, CRC Press, 2003.
2. Cynthia A. Robert, The Food Safety Information handbook by, 2009.
3. Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons, Food Safety Handbook Publication, 2003.
4. Sudheer, K. P.. Safety And Quality Assurance In Food Supply Chain: Emerging Technologies & Challenges. India, New India Publishing Agency (NIPA), 2020.

REFERENCES

1. Huub L. M. Lelieveld, Veslemøy Andersen, Yasmine Motarjemi, Food Safety Management: A Practical Guide for the Food Industry. United States, Elsevier Science, 2023.
2. Frank Devlieghere, Pieter A. Luning, Roland Verhé, Safety in the Agri-food Chain. Netherlands, Wageningen Academic Publishers, 2006.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	1	1	1	2	1	1	3	3	2	3
CO2	1	2	2	2	2	1	1	1	2	1	1	3	3	2	3
CO3	1	2	2	2	2	1	1	1	2	1	1	3	3	2	3
CO4	1	2	2	2	2	1	1	1	2	1	1	3	3	2	3
CO5	1	2	2	2	2	1	1	1	2	1	1	3	3	2	3
Avg	1	2	2	2	2	1	1	1	2	1	1	3	3	2	3

- 1-low, 2-medium, 3-high, ‘ - ‘ - no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The course aims to describe the different packaging materials and packaging systems involved in food packaging and define their application in various food products.

UNIT I BASICS OF PACKAGING**9+12**

Packaging Concepts, definition, Significance, classification. Packaging Development, Retail/Unit; Packaging of foods fresh and processed, Hazards to the Packaging.

PRACTICALS:

- Measurement of thickness of packaging films, papers and boards
- Measurement of water absorption of paper, paper boards

UNIT II PACKAGING MEDIA & MATERIALS**9+12**

Metal packaging- Metals Tinfoil, tinning process, components of tinfoil, tin free can (TFC) types of can, metallic films, lacquers. Glass as package material, manufacture, advantages, disadvantages; Paper as package material, its manufacture, types, advantages of corrugated and paper board boxes. Plastic as package material, classification of polymers, properties of each plastics, uses of each plastic; Caps and closures, inks and lacquers, cushioning materials, reinforcements.

PRACTICALS:

- Measurement of bursting strength of paper of paper boards
- Determination of tensile/compression strength of given material.

UNIT III PACKAGING SYSTEMS AND METHODS**9+12**

Lamination, need of lamination, coefficient of friction, types, properties, advantages & disadvantages of each type. Coating on paper & films, types of coatings. Need of coating, methods of coatings, Vacuum packaging, gas flush packaging - CAP & MAP, aseptic & retort packaging, box in box, edible, Active packaging systems and their food applications.

PRACTICALS:

- Destructive and non-destructive test on glass container, drop test
- Determination of wax weights, tensile strength of papers, bursting strength

UNIT IV PACKAGING OF FOOD PRODUCTS AND TESTING OF PACKAGE**9+12**

General classification and packaging types - Packaging of Specific Foods with its properties – milk and milk products, spices and condiments, fat and oil, fruits and vegetables, meat and sea food, bakery and confectionery, cereals and cereal based products, Interaction of Food Material with Packaging Material, Testing & evaluation of packaging media – retail packs & transport packages.

PRACTICALS:

- Determination of WVTR of various packaging materials
- Determination of Oxygen Transmission Rate of various packaging materials

UNIT V REGULATORY ASPECTS OF PACKAGING

9+12

Food Packaging Laws and Regulations, Food Labelling, coding and marking including bar coding. Packaging Costs; Packaging Environmental consideration and restoration – sustainable development, biodiversity, global environment facility, environmental impact assessment, environmental protection act, national conservation strategies, ISO 14000. & waste management, Sources-Reduce, Reuse and Recycling (3R's), 7R's of Packaging, Biodegradable materials, Recycling techniques/methods – Paper/Paperboard, Plastics, Metals, Glass.

PRACTICALS:

- Determination of coating and residue migration from package to food
- Tests for identification of plastic films.

TOTAL:105 HOURS (45+60)

COURSE OUTCOMES (COs):

At the end of the course the students will be able to

CO1 Understand the importance of packaging and the various packaging media and materials.

CO2 Demonstrate various packaging systems and their food applications.

CO3 Analyze complex systems of food packaging and logistics.

CO4 Analyze the classification of food packaging and assess its suitability based on the interaction with food material.

CO5 Understand the regulatory implications in food labelling and safe disposal strategies of the packaging materials.

TEXTBOOKS

1. Robertson, G.L. "Food Packaging Principles and Practice". 2nd Edition. Taylor & Francis,2006.
2. Han, Jung H. "Innovations in Food Packaging". Elsevier, 2005.
3. Ahvenainen, Raija. "Novel Food Packaging Techniques". Wood Head Publishing, 2003.
4. Mathlouthi, M. "Food packaging and Preservation". Aspen Publications, 2013

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	2	1	2	2	1	1	3	1	2	1	1
CO2	3	2	3	2	1	2	1	2	1	1	2	1	2	2	3
CO3	3	2	3	3	2	2	1	1	2	2	2	2	3	3	3
CO4	3	1	3	2	2	2	1	1	2	1	3	2	3	3	3
CO5	3	3	3	1	1	1	2	1	1	2	2	2	3	3	3
Avg	2.80	1.80	2.80	1.80	1.60	1.60	1.40	1.40	1.40	1.40	2.40	1.60	2.60	2.40	2.60

- 1-low, 2-medium, 3-high, '-' no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The course aims to ensure that students understand the importance of food ingredients in food product formulation.

UNIT I ACIDITY REGULATORS, ANTIOXIDANTS, AND ANTIMICROBIAL AGENTS**9**

Acidity Regulators – definition, chemical structure, role and importance, pH modulation and taste, acidity profile, permitted acidity regulators, levels of usage, and food applications. Antioxidants - Chemistry of oxidative deterioration of food and its constituents and its effect on the quality; defining antioxidants; water soluble and oil soluble antioxidants and their chemical structure, permitted antioxidants; mechanism of action, permitted levels, and food application. Preservatives of chemical and microbial origin; mode of action on spoilage organisms and pathogens, factors affecting the performance of preservatives, active forms of preservatives, necessity in a food and levels of usage; permitted preservatives and food applications. Case studies/illustrations.

UNIT II EMULSIFIERS, STABILIZERS, AND THICKENERS**9**

Emulsion, surface tension, oil in water and water in oil emulsion, Hydrophilic and Lipophilic balance (HLB), role of emulsifiers, different classes of emulsifiers and their chemical structure, their HLB values and role in emulsion stabilization; role of different stabilizers and other substances in emulsion stability; emulsion formation process and equipment; measurement of emulsion stability; permitted emulsifiers and stabilizers and food applications. Optimization of emulsifiers and stabilizers – case study. Thickeners – definition, chemical structure, role in food processing and product end characteristics, list of permitted thickeners and food applications

UNIT III OTHER FOOD ADDITIVES & FOOD INGREDIENTS**9**

Color – Natural and synthetic food colors, their chemical structure, shades imparted, stability, permitted list of colors, usage levels, and food application. Anticaking agents, Antifoaming, Glazing agents, Bulking agents, Humectants, Firming agents, Softening agents, Crystal modifiers, Flour improvers, Flour treatment agents, Dough conditioners, and Enzymes – definition, role and mode of action, permitted list of agents and food application. Proteins, starches, and lipids as functional ingredients; isolation, modification, specifications, functional properties, and applications in foods. Flavour enhancers & maskers- Chemical properties, Functions in foods, Glutamate in foods, Biochemicals & Toxicology. Sweeteners – list, structure, taste profile, permitted list, usage levels, and food applications

UNIT IV FLAVOUR COMPOUNDS**9**

Classification of food flavours; chemical compounds responsible for flavor; Chemical compound classes and their flavour responses; flavour development during biogenesis, flavour development during food processing; use of biotechnology to develop flavours. Aroma compounds, flavour profile, bio-flavor and reconstituted flavor.

UNIT V FLAVOUR PERCEPTION AND ANALYSIS**9**

Flavour and taste perception, smell, and taste sensation, olfaction, flavour compounds, volatile flavour compounds, chemesthesis and chem-esthetic responses, tactile response, Subjective versus Objective methods of analysis; psychophysics and sensory evaluation; Instrumental analysis; sample handling and artifacts; data handling, Flavour legislation, flavour release, Useful principles to predict the performance of polymeric flavor delivery systems, Delivery of flavours from food matrices,

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

- CO1** Understand the significance of anti-microbial, antioxidant, and acidity regulators in chemical preservation in foods.
- CO2** Classify and describe suitable textural enhancers in food formulation.
- CO3** Identify and evaluate the suitability of food colours, functional ingredients, and food flavours
- CO4** Classify flavours and describe their behavior during various stages of formation and processing
- CO5** Understand the mechanism of flavour perception by human sensory organs and instrumental flavour analysis

TEXTBOOKS

1. Fisher, Carolyn and Thomas R. Scott. "Food Flavours Biology and Chemistry". The Royal Society of Chemistry, 1997.
2. Milton, J.S. and Arnold, J.C. "Introduction to Probability and Statistics", Tata McGraw Hill, New Delhi, 4th Edition, 3rd Reprint, 2008.
3. Ross, S.M. "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier, New Delhi, 5th Edition, 2014.
4. Spiegel, M.R., Schiller, J., Srinivasan, R.A. and Goswami, D. "Schaum's Outline of Theory and Problems for Probability and Statistics", McGraw Hill Education, 3rd Edition, Reprint, 2017.
5. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K. "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2011.

REFERENCE BOOKS

1. Reineccius, Gary. "Flavour Chemistry and Technology". 2nd Edition, Taylor & Francis, 2006.
2. Shahidi, Fereidoon and Chi-Tang Ho. "Flavour Chemistry of Ethnic Foods". Kluwer Academic Plenum, 1999.
3. Milton, J.S. and Arnold, J.C. "Introduction to Probability and Statistics", Tata McGraw Hill, New Delhi, 4th Edition, 3rd Reprint, 2008.
4. Ross, S.M. "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier, New Delhi, 5th Edition, 2014.
5. Spiegel, M.R., Schiller, J., Srinivasan, R.A. and Goswami, D. "Schaum's Outline of Theory and Problems for Probability and Statistics", McGraw Hill Education, 3rd Edition, Reprint, 2017.
6. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K. "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2011.
7. Heath, H.B. and G. Reineccius. "Flavour Chemistry and Technology". CBS Publishers, 1996.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	3	1	2	2	2	1	2	2	1	3	2	3
CO2	2	2	1	1	2	1	1	2	1	3	1	2	3	2	3
CO3	3	1	1	1	1	1	1	1	2	2	1	2	3	2	3
CO4	1	1	2	2	3	2	2	1	1	1	2	1	3	2	3
CO5	2	1	1	1	1	1	1	2	2	1	1	1	3	2	3
Avg	2.2	1.2	1.4	1.6	1.6	1.4	1.4	1.6	1.4	1.8	1.4	1.4	3	2	3

- 1-low, 2-medium, 3-high, '-' - no correlation. Note: The average value of this course is to be used for the program articulation matrix.

OBJECTIVES

The course aims to,

- train students to analyze a problem
- make them understand how to find solutions innovatively
- enable them to acquire technical and experimental skills to validate the solution, analyze the results and communicate.

OUTCOMES:

At the end of the course the students will be able to:

- CO1 Formulate and analyze a problem
- CO2 Plan experiments to find solutions in a logical manner
- CO3 Analyze the results, interpret and communicate

PROGRAMME OUTCOMES															
CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	1	1	1	1	2	2	2	1	2	2	2	2
2	2	1	2	2	2	1	2	3	3	2	2	3	3	2	2
3	3	2	3	3	2	2	2	3	3	3	2	3	3	3	2
Overall CO	2.3	1.7	2	2	1.7	1.3	1.7	2.7	2.7	2.3	1.7	2.7	2.7	2.3	2

Course 1-low, 2-medium, 3-high, '-'- no correlation

Note: The average value of this course to be used for program articulation matrix

OPEN ELECTIVE TO OTHER DEPARTMENTS (OEC)

FT23901

TRADITIONAL FOODS

L T P C
3 0 0 3

OBJECTIVES

The course aims to understand the traditional methods of food processing and production and to understand the commercialization and health aspects of traditional and organic foods.

UNIT I HISTORICAL AND CULTURAL PERSPECTIVES

9

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

UNIT II TRADITIONAL METHODS OF FOOD PROCESSING

9

Traditional methods of milling grains – rice, wheat and corn – equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sun-drying, osmotic drying, brining, pickling and smoking.

UNIT III TRADITIONAL FOOD PATTERNS

9

Typical breakfast, meal and snack foods of different regions of India. Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods, pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods

UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

9

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

UNIT V HEALTH ASPECTS

9

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments / illnesses. Organic foods types of organic foods, identifying organic foods, organic food & preservatives.

TOTAL : 45 HOURS

COURSE OUTCOMES(COs):

At the end of the course, the students will be able to

CO 1 understand the historical and traditional perspective of foods and food habits

CO 2 understand the methods of processing traditional Indian foods

CO3 gain knowledge on Indian traditional meal patterns.

CO4 describe on method of production of various traditional foods

CO5 familiarize with health benefits of bioactive components rich traditional foods over junkfoods

TEXTBOOKS

- 1.Sen, Colleen Taylor “Food Culture in India” Greenwood Press, 2005.Davidar, Ruth N.“Indian Food Science A Health and Nutrition Guide to Traditional Recipes,East West
2. Mohammad Shafiur Rahman, Mohammed Al-Khusaibi, Nasser Al-Habsi, Traditional Foods: History, Preparation, Processing and Safety. Springer International publishing, 2019.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	2	1	1	1	1	2	2	1	1	1	1	2
CO2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	2
CO3	2	3	2	1	1	1	1	1	2	1	1	2	1	1	2
CO4	1	2	2	2	1	1	1	1	2	1	1	1	1	1	2
CO5	1	2	3	1	1	1	1	1	3	1	1	3	1	1	2
Avg	1.2	2.00	2.00	1.40	1.00	1.00	1.00	1.00	2.00	1.2	1.00	1.60	1.00	1.00	2.00

OBJECTIVES

To create awareness of adulterants, present in food and their detection technique.

UNIT I INTRODUCTION TO ADULTERANTS**9**

Food adulterants – Introduction – Definition of adulterant – Food adulteration – Types of adulterants, Intentional, incidental adulterants, and metallic contaminants – Preventing food adulteration – Food classification – Effects of food adulteration – Prevention of Food Adulteration Act – National and International scenario.

UNIT II CEREAL AND CEREAL PRODUCTS**9**

Cereal and cereal products – Adulterants and screening techniques – Bread, Flour and grain foods – Alum – Copper sulfate – Substituted flours – General test – Corn meal in wheat flour – Wheat flour in rye flour – Ergot in rye flour. Spices – mustard, pepper, etc. Coloring matter – Turmeric – Martius yellow or analogous synthetic coloring matter – Cayenne pepper. Adulterants and screening techniques for fats and oils. Adulterants and screening techniques – Coffee – General test – Coloring matter – Chicory. Tea – Foreign leaves – Exhausted tea leaves.

UNIT III MILK AND MILK PRODUCTS**9**

Milk and Milk Products – Adulterants and screening techniques – Coloring matters – Annatto – Caramel – Synthetic colors – Preservatives – Formaldehyde – Boric acid – Salicylic acid – Gelatin – Starch – Urea. Butter & Ghee – Coloring matter – Synthetic Flavors – Hydrogenated Fats. Preparation of sample – Process or renovated butter – Oleomargarine – Cottonseed oil.

UNIT IV MEAT AND MEAT PRODUCTS**9**

Meat and Meat products – Adulterants and screening techniques – Fresh and smoked – Preservatives – Potassium nitrate – Boric acid – Sulfurous acid – Salicylic acid – Benzoic acid – Canned – Preservatives – (same as those of fresh and smoked meat) – Heavy metals – Coloring matter. Fish, salt, dried and oysters – Preservatives – Boric acid (same under smoked and fresh meat) – Coloring matter – Aniline red and cochineal-carmine – In sausages, chopped meat, preparations, and corned meat – Starch – In sausages, deviled meat and similar products – Diseased meats – Horse-flesh in sausages and mince-meat. Eggs – Age test.

UNIT V FRUIT AND VEGETABLE PRODUCTS**9**

Fruit and vegetable – Fruit and vegetable Products – Adulterants and screening techniques – Preservatives – Artificial ripening – Preparation of sample – Salicylic acid – Benzoic acid – Saccharin – Coloring matter – Synthetic dyes – Cochineal – magenta – Apple juice in jellies made from small fruits – Detection – Starch in jellies, jams and such products – Gelatin – in juices – Agar agar – Heavy metals – Arsenic.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO1 Understand the food adulteration and prevention methods.

CO2 Gain knowledge on food adulteration in cereal and cereal products.

CO3 Gain knowledge on food adulteration in milk and milk products.

CO4 Familiarizes with adulteration in meat and meat products.

CO5 Understand the adulteration in fruits and vegetable products.

TEXTBOOKS

1. Anupama Rani. Food Adulteration and Hygiene. Sonali Publications, 2010.
2. W. D. Bigelow and Burton J. Howard. Some forms of food adulteration and Simple methods for their detection. USDA. Bureau of Chemistry Bulletin No. 100, 2017.
3. Edwin M. Rruce. Detection of the Common Food Adulterants. The Plimpton Press Norwood Mass. 2012.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	1	1	1	2	1	2	1	2	1	1	2	3	3
CO2	1	2	1	1	1	2	2	2	1	3	1	1	2	3	3
CO3	2	3	2	1	1	1	1	1	2	1	2	2	2	3	3
CO4	1	1	2	3	1	2	1	2	1	2	1	1	2	3	3
CO5	1	2	3	1	1	1	1	1	2	1	1	2	2	3	3
Avg	1.2	2	1.8	1.4	1	1.6	1.2	1.6	1.4	1.8	1.2	1.4	2	3	3

- 1-low, 2-medium, 3-high, '- ' - no correlation. Note: The average value of this course to be used for the program articulation matrix.

EMERGING TECHNOLOGY COURSES (ETC)

FT23E01

FOOD INFORMATICS

L	T	P	C
3	0	0	3

OBJECTIVES:

To acquaint the students with the concepts of informatics databases and models.

UNIT I INTRODUCTION

9

Role of functional foods against metabolic syndrome like diabetics, celiac diseases. Potential benefits (like antioxidant, anticancer activity) of active compounds present in the food materials (herbs, fruits, & vegetables) – proteins and phytochemicals like – Carotenoids, Lycopene, Xanthophylls, lutein, Sulfides, Polyphenolics, Flavonoids, Naringin, Quercetin, Anthocyanidins, catechins, Flavones, Prebiotics / Probiotics, Fructo oligosaccharides, Lactobacillus, Phyto estrogens: Isoflavones, daidzein, Geebustin, lignans, Tocopherols, etc.

UNIT II SEQUENCE DATABASE

9

Introduction to bioinformatics tools: Sequence database – Nucleotide, protein, Literature Databases, Composite Databases (NRDB), Genome Databases- (Viral genome database (ICTV db)), Bacterial Genome database (GOLD, MBGD), Organism specific database. file formats, Introduction to sequence alignment (only general ideas, not algorithm) – Local and global, pair wise and multiple, BLAST. Small compound database

UNIT III ONLINE TOOLS

9

PubChem, ChemSpider, ZINC, ChEMBI, Drug Bank, Flavornet (Volatile compounds from the literature based on GC-MS), SuperSweet (Database – Carbohydrates & artificial sweeteners).

UNIT IV IN SILICO Models

9

Introduction to Molecular docking, Structure Based methods to identify lead components, Energy minimization tool, Denovo ligand design, molecular docking and molecular simulation case studies.

UNIT V NVITRO Models

9

Introduction – preparation of cell culture media and its requirements. Preservation cell line cultures – cryopreservation. Facts of cell line contamination; cell line studies: Anti-diabetic, Anti-Cancer, and Anti-inflammation activity. cytotoxicity by MTS assay. Case studies.

TOTAL: 45 PERIODS

OUTCOMES:

- CO 1 : Understand the active compounds in food products.
- CO 2 : Apply bioinformatics tools to understand the functions of the compounds.
- CO 3 : Use different online tools to understand the properties of the food components.
- CO 4 : Understand *insilico* models and molecular simulation.
- CO 5 : Familiarize with cell culture studies.

TEXT BOOKS:

1. Karina M.M. and José L.M.F. Food Informatics – Applications of Chemical Information to Food Chemistry. Springer, Switzerland, 2014.

2. Dash, S., Acharya, B. R., Mittal, M., Abraham, A., & Kelemen, A. (Eds.). Deep learning techniques for biomedical and health informatics. Cham, Switzerland: Springer International Publishing, 2020.
3. Choudhury A., Biswas A., Prateek M., Chakrabarti A, Agricultural Informatics. Scrivener Publishing LLC, 2021.

FT23E02

FOODOMICS

**LT P C
3 0 0 3**

OBJECTIVE

The course aims to provide students a foundation about food omics technologies and its applications.

UNIT I INTRODUCTION TO FOODOMICS 9

Types of omics measurements – genomics, transcriptomics, proteomics, metabolomics. Omics subdisciplines – epigenomics, lipidomics, interactomics, metallomics, diseasomics.

UNIT II FOOD DATABASES 9

Nutrient composition of food, procedures for data collection, procedures for data entry into foodomics database, precision ketogenic therapy, diet prescription for patients.

UNIT III FOODOMICS TECHNOLOGIES 9

Multivariate data analysis, infrared (IR) spectroscopy, biomarkers, food quality attributes, metabolite identification, chemometrics, data mining, machine learning, applications in health studies.

UNIT IV CHARACTERIZATION OF FOODS 9

Structure of food, ultra-processed foods (UPFs), epidemiological studies, food intake biomarkers, clinical parameters, health status, nutrient bioaccessibility and bioavailability.

UNIT V MODERN APPLICATIONS FOR FOODOMICS 9

Food production chain, global food distribution, bioactive role of foods, PCR testing and DNA sequencing, food profiling, food fingerprinting, genetic lines, authentication, and traceability of foods.

TOTAL: 45 HOURS

COURSE OUTCOMES:

- CO1 To obtain knowledge on food omics technologies.
- CO2 To evaluate and predict ways in which complex interactions of components of the food system influences human health and nutrition.
- CO3 To assess food biomarkers and targets.
- CO4 To describe the characterization of foods.
- CO5 To understand the applications of foodomics

TEXTBOOKS

1. Jorge B.V., Foodomics – Omic Strategies and Applications in Food Science. Royal Society of Chemistry, 2021.
2. Cifuentes A., Comprehensive Foodomics. United States: Elsevier Science, 2020.
3. Cifuentes A., Foodomics: Advanced Mass Spectrometry in Modern Food Science and Nutrition. United States: Wiley, 2013.

SKILL DEVELOPMENT COURSES (SDC)

FT23S02

SUSTAINABLE FOOD PRODUCT DEVELOPMENT

LT P C

1 0 2 3

OBJECTIVES:

To gain foundational knowledge, practical applications, and market considerations to provide a comprehensive understanding of sustainable food product development.

UNIT I INTRODUCTION TO SUSTAINABLE FOOD SYSTEMS

9

Overview of Sustainability in Food Production - Definitions, principles, and importance; Environmental Impacts of Conventional Food Systems - Resource use, pollution, and waste; Sustainable Food Systems Framework - Key concepts and strategies for sustainability.

UNIT II SUSTAINABLE INGREDIENTS AND SOURCING

9

Sustainable Agriculture Practices - Organic farming, permaculture, and regenerative agriculture; Ethical Sourcing - Fair trade, local sourcing, and reducing food miles; Alternative Ingredients - Plant-based proteins, insect proteins, and innovative materials.

UNIT III SUSTAINABLE FOOD PRODUCT DESIGN

9

Design Principles for Sustainable Products - Lifecycle assessment, eco-design, and minimalism; Formulation and Development - Balancing taste, nutrition, and environmental impact; Packaging Innovations - Sustainable packaging materials and techniques.

UNIT IV CONSUMER TRENDS AND MARKET ANALYSIS

9

Consumer Preferences and Behavior - Trends in sustainable food consumption, Market Analysis - Identifying target markets, understanding consumer demand, and market positioning; Case Studies - Successful examples of sustainable food products and companies.

UNIT V IMPLEMENTATION AND EVALUATION

9

Regulatory and Certification Standards - Organic, Fair Trade, and other certifications; Sustainability Metrics and Evaluation - Measuring and reporting sustainability performance; Product Launch and Marketing Strategies - Effective strategies for introducing and promoting sustainable food products.

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

- CO1:** Comprehend Sustainability Concepts
- CO2:** Analyze and Select Sustainable Ingredients
- CO3:** Design Sustainable Food Products
- CO4:** Evaluate Market Dynamics
- CO5:** Implement and Assess Sustainable Practices

TEXTBOOKS:

1. Ronald J. W. L. Davis, Patrick D. H. Lee, Sustainable Food Systems: A Global Life Cycle Perspective, Academic Press, 2020.
2. Nick Hurd, The Future of Food: How Digital Technology Will Transform the Food Industry, CRC Press, 2021.

3. Janice M. Thompson, Judy A. Harrison, *Food Product Design: An Integrated Approach*, Wiley-Blackwell, 2019.
4. Heather R. Faulkner, *Consumer Behavior in Food and Nutrition: Understanding the Sustainable Food Market*, Routledge, 2022.

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS**9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

UNIT II INTRODUCTION TO PROJECT MANAGEMENT**9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS**9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL**9**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT**9**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve

TOTAL: 45 PERIODS**COURSE OUTCOMES(COs):**

Upon successful completion of the course, students should be able to:

CO1: Understand the costing concepts and their role in decision making.

CO2: Understand the project management concepts and their various aspects in selection.

CO3: Interpret costing concepts with project execution.

CO4: Gain knowledge of costing techniques in service sector and various budgetary control techniques.

CO5: Become familiar with quantitative techniques in cost management.

TEXT BOOKS:

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.

2. Albert Lester, Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

OBJECTIVES

The course aims to understand the process development and design consideration of food plant layout, understand the quantitative analysis of cost estimation and practical consideration of food plant layout.

UNIT I OVERALL DESIGN OF AN ENTERPRISE 10

Plant design, sales planning for plant design. Plant Location, levels of Plant location. Location of layout location factors, plant site selection. Location theory and models, industrial buildings and grounds. Classification of Dairy and Food Plants, farm level collection and Chilling centre. Space requirement.

UNIT II PREPARATION OF A PLANT LAYOUT 10

Plant Layout problem, importance, objectives, classical types of layouts. Evaluation of Plant layout. Advantages of good layout. Organizing for Plant Layout, Data forms. Development of the pilot layout, constructing the detailed layout Functional design, Siting of different sections in a plant, Layout installations.

UNIT III DEVELOPMENT AND PRESENTATION OF LAYOUT 10

Engineering economy, Linear programming, Queuing theory, Common Problems in Plant Layout and Process scheduling, Siting of Process sections, Equipment selection and capacity determination, Arrangement of process, and service equipment, Estimation of Services and Utilities, Office layout, line balancing, Flexibility. Practical layouts Common materials of construction of Food plant, building. Maintenance of Food Plant Building, Illumination and ventilation, Cleaning & sanitization, painting and colour coding, Fly and insect control.

TOTAL: 30 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO 1 Design and set-up a new food processing plant as entrepreneur and/or consultant.

CO 2 Understand the food industry losses and maximize the processed food production.

CO 3 Prepare cost estimate and economic analysis of a food industry.

TEXT BOOKS:

1. M Moore, Mac Millan, "Plant Layout & Design". Lames, New York, 1971.
2. H.S. Hall & Y.S. Rosen, "Milk Plant Layout". FAO Publication, Rome, 1963.
3. Antonio Lopez-Gomez, Gustavo V. Barbosa-Canovas, "Food Plant Design (Food Science and Technology)", CRC Press, 2005.

REFERENCES:

1. "Food plant engineering system" by Theunis C. Robberts, II Edition, CRC Press, Washington, 2013.
2. "Food plant economic" by Zacharias B. Maroulis and George D. Saravacos published by Taylor and Francis Group, LLC, 2008
3. John Holah, HuubLelieveld, "Hygienic Design of Food Factories", Woodhead Publishing, 2011.
4. Slade, S. "Food Processing Plant" Vol. 1, Leonard Hill Books, 1990.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	3	2	3	3	1	3	2	3	3	1
CO2	2	3	2	3	3	1	2	1	3	1	3	2	3	3	2
CO3	2	3	2	3	2	3	1	3	3	1	3	2	3	3	2
Avg	2.3	3	2.3	2.6	2.6	2.3	1.6	2.3	3	1	3	2	3	3	1.6

- 1-low, 2-medium, 3-high, '-' no correlation. The average value of this course to be used for program articulation matrix.

INDUSTRY ORIENTED COURSES (IOC)

INSTANT NOODLES TECHNOLOGY

LT P C
1 0 0 1

OBJECTIVES

- To impart knowledge on the scope and importance of the instant noodle industry.
- To provide an understanding of the processing aspects of instant noodles.
- To explore the market dynamics and regulatory environment of instant noodles.

UNIT I INTRODUCTION

3

Classification of instant noodles and their significance. Scope of the instant noodle industry in India and globally. Historical evolution and market trends. Overview of different types of instant noodles. Ingredients used in instant noodles.

UNIT II INGREDIENTS AND FORMULATION

3

Ingredients used in instant noodle production: Wheat flour, starches, water, salts, and other additives. Nutritional aspects and fortification. Formulation of dough for different types of instant noodles. Role of gluten and other functional ingredients.

UNIT III PROCESSING TECHNOLOGY

3

Processing techniques: Mixing, sheeting, steaming, cutting, frying, and drying. Equipment used in each step of processing. Instant noodle manufacturing: Fresh noodles, steamed noodles, and fried noodles. Packaging techniques and materials used. Shelf life of instant noodles.

UNIT IV QUALITY CONTROL AND SAFETY

3

Quality control measures in instant noodle production: Chemical, microbial, and sensory evaluation. Nutritional evaluation of instant noodles. Common quality issues and their solutions. Hygiene and sanitation in noodle manufacturing. Safety standards and regulations.

UNIT V MARKET TRENDS AND INNOVATIONS

3

Market trends and consumer preferences in instant noodles. Innovations in instant noodle production: Low-fat noodles, whole grain noodles, and gluten-free noodles. Flavoring and seasoning development. Environmental considerations and sustainable practices in instant noodle production.

TOTAL: 15 HOURS

COURSE OUTCOMES (COs):

At the end of the course, students will be able to:

CO1: Understand the ingredients and their functions in instant noodle production.

CO2: Apply knowledge of unit operations involved in the manufacturing of instant noodles.

CO3: Evaluate the quality parameters and nutritional aspects of instant noodles.

CO4: Implement food safety laws and regulations relevant to instant noodle production.

CO5: Analyze market trends and consumer preferences to innovate and improve instant noodle products.

TEXTBOOKS

1.Hou, G. (2010). Asian Noodles: Science, Technology, and Processing. Wiley-Blackwell.

2.Fellows, P.J. (2009). Food Processing Technology: Principles and Practice. Woodhead Publishing.

3.Bowers, J. (2013). Food Processing: Principles and Applications. Wiley-Blackwell.

4.Riaz, M.N. (2000). Extruders in Food Applications. CRC Press.

REFERENCES

1.Manay, S.N., Shadaksharaswamy, M. (2004). Foods: Facts and Principles. New Age International Pvt. Ltd.

2.Kruk, M. (2016). Instant Noodles: Technology and Innovation. Academic Press.

3.Jianshe, C., & Xueming, X. (2013). Noodles: Processing Technology and Quality Improvement. Wiley-Blackwell.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	1	1	2	3	1	1	1	2	2	2	3	1	2
CO2	1	2	2	2	1	1	1	1	2	2	2	2	2	2	2
CO3	2	1	1	1	1	1	2	2	1	1	2	2	3	2	1
CO4	2	1	2	2	2	2	2	2	1	3	3	3	1	1	2
CO5	1	1	2	1	3	3	2	3	1	3	1	3	1	2	1
Avg	1.4	1.4	1.6	1.4	1.8	2	1.6	1.8	1.2	2.2	2	2.4	2	1.6	1.6

- 1-Low, 2- Medium, 3- high, 'no correlation. Note: The average value of this course is to be used for the program articulation matrix.

OBJECTIVES

- To impart knowledge on the scope and importance of waste management in the food industry.
- To provide an understanding of the various types of waste generated and their environmental impact.
- To explore techniques and strategies for effective waste management, recycling, and resource recovery in the food industry.

UNIT I INTRODUCTION TO WASTE MANAGEMENT 3

Overview of waste management in the food industry. Types and sources of waste: solid, liquid, and gaseous. Environmental impact of food waste. Regulatory frameworks and standards: FSSAI, EPA, EU regulations, and local guidelines. Economic and social implications of food waste.

UNIT II SOLID WASTE MANAGEMENT 3

Classification of solid waste in the food industry. Collection, segregation, and disposal methods. Techniques for reducing, reusing, and recycling solid waste. Composting, anaerobic digestion, and waste-to-energy technologies. Case studies of successful solid waste management programs.

UNIT III LIQUID WASTE MANAGEMENT 3

Types of liquid waste: wastewater, effluents, and by-products. Primary, secondary, and tertiary treatment methods. Biological treatment processes: aerobic and anaerobic systems. Advanced technologies: membrane filtration, UV disinfection, chemical treatments. Reuse and recycling of treated wastewater. Case studies of effective systems.

UNIT IV GASEOUS WASTE MANAGEMENT 3

Sources and types of gaseous waste: emissions, odors, VOCs. Techniques for controlling and treating gaseous waste: biofiltration, adsorption, chemical scrubbing. Odor management strategies. Impact on air quality and climate change. Regulatory requirements and compliance.

UNIT V RESOURCE RECOVERY AND SUSTAINABILITY 3

Principles of resource recovery and circular economy. Technologies for recovering valuable by-products: biogas, biofuels, biomaterials. Innovations in waste reduction and resource efficiency. Sustainable packaging solutions and waste minimization strategies. Corporate social responsibility (CSR) and sustainability reporting.

TOTAL: 15 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, students will be able to:

- CO1.** Understand the types and sources of waste in the food industry and their environmental impact.
- CO2.** Apply knowledge of solid, liquid, and gaseous waste management techniques in the food industry.
- CO3.** Improve waste management practices.
- CO4.** Implement regulatory requirements and best practices for waste management in the food industry.
- CO5.** Analyze the principles of resource recovery and sustainability to innovate.

TEXTBOOKS

1. Arvanitoyannis, I.S. (2008). Waste Management for the Food Industries. Academic Press.

2. Guerrero, L., Maas, G., Hogland, W. (2013). Solid Waste Management: Practices in Developing Countries. CRC Press.
3. Shah, K. (2000). Basics of Solid and Hazardous Waste Management Technology. Prentice Hall.
4. Lema, J.M., Suarez, S. (2017). Innovative Wastewater Treatment & Resource Recovery Technologies: Impacts on Energy, Economy and Environment. IWA Publishing.

REFERENCES

1. Wang, L.K., Hung, Y.T., Shammass, N.K. (2007). Handbook of Environmental Engineering: Advanced Physicochemical Treatment Processes. Humana Press.
2. Sun, D.W. (2018). Handbook of Food Safety Engineering. Wiley-Blackwell.
3. Simpson, S. (2014). Food Industry Waste: Assessment and Recuperation of Commodities. Wiley-Blackwell.
4. Smith, J., Charter, E. (2010). Functional Food Product Development. Wiley-Blackwell.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	2	2	3	1	2	2	2	1	1	3	2	2
CO2	2	1	2	2	1	1	2	1	1	2	1	1	2	2	2
CO3	3	2	2	2	1	1	2	1	2	1	2	2	3	2	1
CO4	2	3	2	2	3	2	1	2	3	3	1	2	2	1	2
CO5	1	1	2	1	2	3	1	3	1	1	2	1	2	1	1
Avg	1.8	1.6	2	1.8	1.8	2	1.4	1.8	1.8	1.8	1.4	1.4	2.4	1.6	1.6

- 1-Low, 2- Medium, 3- high, '-no correlation. Note: The average value of this course is to be used for the program articulation matrix.

OBJECTIVES

- To explore the impact of digital technologies on the food industry.
- To understand the applications of IoT, AI, and big data in food production, processing, and distribution.
- To study the role of digital tools in enhancing food safety, quality, and traceability.
- To develop skills for implementing digital transformation strategies in the food industry.

UNIT I INTRODUCTION TO DIGITAL TRANSFORMATION 3

Overview of digital transformation in the food industry. Key drivers and benefits of digitalization. Challenges and barriers to digital adoption. Digital technologies: Internet of Things (IoT), Artificial Intelligence (AI), Machine Learning (ML), Big Data, Blockchain, and Robotics. Case studies on digital transformation initiatives in the food sector.

UNIT II IoT AND SMART AGRICULTURE 3

Applications of IoT in smart farming: precision agriculture, automated irrigation systems, and livestock monitoring. Use of sensors and drones for data collection and analysis. Benefits of IoT in enhancing crop yield, resource efficiency, and sustainability. Integration of IoT with AI for predictive analytics and decision support systems.

UNIT III AI AND AUTOMATION IN FOOD PROCESSING 3

Role of AI and automation in food processing and manufacturing. Applications of AI in quality control, process optimization, and predictive maintenance. Use of robotics for packaging, sorting, and palletizing. AI-driven food safety monitoring and inspection systems. Case studies on AI and automation in the food industry.

UNIT IV BIG DATA AND FOOD SUPPLY CHAIN MANAGEMENT 3

Importance of big data analytics in the food supply chain. Data sources and types: production, processing, distribution, and retail. Techniques for data collection, storage, and analysis. Applications of big data in demand forecasting, inventory management, and logistics optimization. Enhancing traceability and transparency with blockchain technology.

UNIT V DIGITAL TOOLS FOR FOOD SAFETY AND QUALITY 3

Digital platforms for food safety management: traceability systems, digital twins, and smart labels. Use of mobile apps and cloud-based solutions for real-time monitoring and reporting. Role of blockchain in ensuring food authenticity and preventing fraud. Regulatory aspects and standards for digital tools in food safety and quality assurance.

TOTAL: 15 HOURS**COURSE OUTCOMES (COs)**

At the end of the course, students will be able to:

- C01:** Understand the impact of digital technologies on the food industry.
- C02:** Apply IoT and AI technologies to improve food production and processing.
- C03:** Utilize big data analytics for efficient food supply chain management.
- C04:** Implement digital tools for enhancing food safety and quality.
- C05:** Develop strategies for successful digital transformation in the food industry.

TEXTBOOKS

1. Bhardwaj, A., Agrawal, G. (2021). Digital Transformation in Food and Beverage Industry. Springer.
2. Charlebois, S. (2017). Digital Food: From Paddock to Plate. IGI Global.
3. Garcia-Torres, S., Albareda, L., Seuring, S. (2019). Sustainability in the Food Sector: Rethinking the Relationship with the Digital Transformation. Springer.
4. Deng, H., Gao, L. (2018). IoT-Based Intelligent Modelling for Environmental and Food Monitoring Springer.

REFERENCES

1. Roberts, A., Williamson, K. (2019). Big Data in the Food Industry: Applications and Case Studies. CRC Press.
2. Mhlanga, S., Dube, E. (2020). Artificial Intelligence and Smart Agriculture Technology: Improving Food Security and Sustainability. CRC Press.
3. Liu, Y., Wang, L. (2020). Blockchain and Supply Chain Management: Enhancing Traceability and Transparency in the Food Industry. Elsevier.
4. Sander, T. (2019). Digital Twins for Food Safety and Quality Management. CRC Press.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	1	2	3	2	2	2	1	1	1	2	1	3	3
CO2	1	2	2	2	3	1	2	1	1	2	2	2	1	2	2
CO3	2	1	2	1	2	3	1	1	1	2	1	3	3	2	1
CO4	3	1	1	1	1	2	1	2	3	3	1	3	1	2	2
CO5	1	2	2	1	2	1	2	3	1	3	2	1	2	2	1
Avg	1.6	1.6	1.6	1.4	2.2	1.8	1.6	1.8	1.4	2.2	1.4	2.2	1.6	2.2	1.8

- 1-Low, 2- Medium, 3- high, '-no correlation. Note: The average value of this course is to be used for the program articulation matrix.

PROFESSIONAL ELECTIVE COURSE (PEC) VERTICALS

FT23001

DAIRY CHEMISTRY AND MICROBIOLOGY

L T P C

3 0 0 3

OBJECTIVES

- To impart the basic knowledge on all aspects of milk components.
- To understand microbiology of dairy products, significance of different food microorganisms, their control and other related aspects.
- To Provide insights on the quality control in relation to dairy industry and impart basic knowledge on all aspects of chemical quality assurance.
- To impart the advanced knowledge on the use of analytical techniques in Dairy Chemistry and microbiology

UNIT I CHEMISTRY OF MILK PROTIEN AND LIPIDS

9

Major milk proteins: caseins (acids and micellar), methods of isolation; fractionation of casein and heterogeneity, physico-chemical properties, glycosylation, phosphorylation, amino acid composition, primary and secondary structure of different fractions; casein micelle models Distribution and fractionation of different nitrogen fractions of milk proteins, Denaturation of milk proteins, various factors affecting denaturation; casein-whey protein interactions. Milk lipids: classification, gross composition and physical properties; neutral and polar lipids and their role in milk and milk products. Fatty acids profile: composition, properties and factors affecting them. Unsaponifiable matter: composition with special reference to sterols and fat-soluble vitamins and carotenoids, chemistry, physiological functions and levels of milk.

UNIT II CHEMISTRY OF MILK CARBOHYDRATES, VITAMINS, AND MINERALS

9

Lactose: occurrence, isomers; molecular structure, Physical properties:- crystalline habits; hydrate; lactose glass; equilibrium of different isomers in solution; solubility; density sweetness; Chemical properties:- hydrolysis; pyrolysis; oxidation; reduction; degradation with strong bases; derivatives, dehydration and fragmentation browning reaction; oligosaccharides in milk Minerals: major and minor minerals; factors associated with variation in salt composition Physical equilibrium amongst milk salts; partitioning of salt constituents and factors affecting it; effect of various treatments on salt equilibrium, Salt balance and its importance in the processing of milk; protein mineral interactions; distribution and importance of trace elements in milk; Water soluble vitamins: thiamine; riboflavin; niacin; pantothenic acid; pyridoxine; biotin; folacin (folic acid) and cyanocobalamin; Molecular structure; levels in milk and milk products; biological significance; factors affecting their levels; ascorbic acid structure; relation to Redox potential (Eh) of milk and milk products.

UNIT III MICROBIOLOGY OF PROCESSED DAIRY FOODS

9

Introduction to microbes in processed dairy foods, history and development of processed foods. Microorganisms important in processed foods: spoilage and pathogens, Food borne new emerging pathogens, Microbial ecology of processed foods and food ecosystem, biofilm formation, Factors influencing microbial growth in foods: Intrinsic factors, Extrinsic factors. Rapid assessment of dairy food for microbial and non-microbial contaminants; Enumeration principles in detection methods of predominant spoilage organisms, pathogens and indicator

organisms like, E.coli, Salmonella, Shigella, Staphylococcus aureus, Bacillus cereus.

UNIT IV ANALYTICAL TECHNIQUES IN DAIRY CHEMISTRY AND MICROBIOLOGY

9

Electrophoresis: principle and types, isoelectric focussing. Column Chromatography, TLC, GLC, HPLC, gel-permeation, ion-exchange, affinity chromatography Spectrophotometry: UV, visible, IR and flame photometry; potentiometry: principle, various electrodes; buffers. Immunobased analytical techniques such as ELISA & Lateral flow assay Separation of bio-molecules using membranes; ultracentrifugation.

UNIT V CHEMICAL QUALITY ASSURANCE IN DAIRY INDUSTRY

9

Concept of quality assurance and quality control in relation to dairy industry; quality management systems - ISO 9000; total quality management (TQM); hazard analysis of critical control points (HACCP); good manufacturing practices (GMP); role of international organisations such as ISO; IDF; CAC; AOAC; WTO and national organisations like BIS; CCFS; Good laboratory practices (GLP), laboratory Accreditation PFA and Agmark; significance of milk and milk products order (MMPO) and APEDA (Agricultural and Processed Foods Export Development Authority) in dairy industry; Instrumentation in analysis of milk and milk products; detection of adulterants in milk and milk products; Quality of packaging material for dairy products, Chemical contaminants /residues: pesticides; antibiotics; heavy metals; radionuclides etc. in dairy products.

TOTAL:45 PERIODS

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

- CO1** Describe the composition of milk, physicochemical characteristics of the main components and identify the beneficial and spoilage microorganisms.
- CO2** Apply advanced analytical techniques to understand the various chemical and microbiological components.
- CO3** Integrate the knowledge of food chemistry/engineering/microbiology and physical properties of foods with processing of dairy products.
- CO4** Apply the analytical techniques in Dairy Chemistry and microbiology
- CO5** Understanding the quality assurance and quality control of dairy products

TEXTBOOKS

1. Nielsen, S. Suzanne 1994. Introduction to the Chemical Analysis of Foods, Jones and Barlett Publishers, Boston, London.
2. Cooper, T.G. 1977. The Tools of Biochemistry, John Wiley & Sons, U.S.A.
3. Williams, P.A. and Phillips, G.O. 2000. Gums and Stabilizers for the Food Industry. Royal Society of Chemistry
4. Dairy Chemistry and Biochemistry (1998) by P.F.Fox and P.L.H McSweeney
5. Textbook of Dairy Chemistry by M.P.Mathur, D.D.Roy and P.Dinakar.
6. ISI Handbook of Food Analysis S.P. 18 (Part II) Dairy Products. 1981 ISI Specifications (concerned) (ISI)

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O2	PS O3
CO1	1	2	1	1	2	2	2	1	1	1	1	1	2	2	1	2
CO2	2	3	3	2	3	3	3	2	2	1	2	1	3	2	1	2
CO3	3	3	2	2	2	3	3	1	1	1	2	1	3	3	2	2
CO4	4	3	3	2	3	3	2	2	2	1	2	1	2	1	1	1
CO5	2	1	3	1	2	2	2	1	2	1	2	1	1	2	1	1
Avg	2.4	2.4	2.4	1.6	2.4	2.6	2.4	1.4	1.6	1	1.8	1	2.2	2	1.2	1.6

- 1-low, 2-medium, 3-high, ‘-’- no correlation. Note: The average value of this course is to be used for the program articulation matrix.

OBJECTIVES

- To project the significance and status of traditional and value added dairy products in Indian dairy industry.
- To explain the current status of traditional milk products in India. Place of milk products in the dietary regime in Indian population.

UNIT I NATIVE DAIRY PRODUCTION 9

Introduction of Traditional dairy products in India, definition – present status and market potential of traditional dairy products – globalization of traditional dairy products – classification of traditional milk products. fermented traditional dairy products. plans and policies of the Government and developmental agencies.

UNIT II HEAT ACID COAGULATED PRODUCTS 9

Chhana- definition- composition- methods of manufacture, Chhana based sweets-packaging and preservation methods- yield and cost analysis. Paneer: definition mechanization of paneer manufacturing - paneer based products – storage and packaging and preservation methods – Latest development in paneer processing. Advances in industrial production of ghee, flavour and texture simulation. New products based on fruits, vegetables and cereals, Application of membrane technology; Microwave heating for industrial production of traditional dairy products.

UNIT III THERMALLY PROCESSED MILK COMMODITY 9

Khoa – Classification- methods of manufacture – Factors affecting yield of khoa- yield and cost analysis of khoa. Processing of khoa –burfi, peda, milk cake, kalakand, gulab jamun, rabri, malai, khurchan, basundhi-composition – manufacturing technicalities. UHT flavoured milk processing and adulterations, Cost of manufacture and storage of traditional flavoured milk products.

UNIT IV MILK CHEESE CURD-BASED BY-PRODUCTS 9

Chhana – Product description, methods of manufacture, packaging and preservation. Chhana based sweets – Rasogolla, Sandesh, Rasmalai, and Chhanapodo - manufacturing practices, compositional profile and mechanization of manufacturing process. Kheer and Payasam – Product description, production and processing, sensory estimation, In-can sterilization of Kheer

UNIT V CONVENIENT TRADITIONAL DAIRY PRODUCTS & NEW PACKAGING TECHNOLOGIES 9

Packaging processes (canning) – interaction between milk and cereal constituents- yield and cost benefit analysis. Convenience traditional dairy products; use of natural and permitted synthetic preservatives with new packaging systems. Techno-economic aspects for establishing commercial units for traditional products. Manufacture of convenience dairy foods, Use of natural preservatives in traditional dairy foods, Use of permitted synthetic preservatives in traditional dairy foods, Scope for packaging of traditional dairy foods.

TOTAL:45 PERIODS**COURSE OUTCOMES (COs):**

Upon completion of the course students will be able to

CO 1 Study common terminology used in packaging of milk and milk products

CO 2 understand how to increase the selling of milk and milk products by attractive packages.

- CO 3** Know about how to increase products claim in market by using different package techniques, and legal requirements.
- CO 4** Get information about methods sterilization and traditional way of processing the value added milk products
- CO 5** Know about importance of coding and labelling of packages

TEXTBOOKS

1. Aneja.R.P, B.N Mathur, R.C Chandra and A.K. Banerjee 2002,Technology of Indian Milk and Milk Products, Dairy India Publication
2. Dairy India year book 2007 & 2017, A- 25 Priyadarshinivihar, Delhi 110092, India.
3. David.J, 2009 “Technologies advanced in indigenous milk products” published by KitabMahal, 22-A, Sarojini Naidu Marg, Allahabad (2nded).
4. Eeckless C.H, W.B Combs and H.Mecy (1955), Milk and Milk Products, Tata McGraw Hill Publishing Co.Pvt.Ltd. New Delhi.
5. Sukumar De (1980), Outlines of Dairy Technology, Oxford University Press, New Delhi.

REFERENCE BOOKS:

1. Achaya KT & Rangappa KS. 1975. Indian Dairy Products. 2nd Ed. Asia Publ. House.
2. Aneja RP, Mathur BN, Chandhan RC & Banerjee AK. 2002. Technology of Indian Milk Products. Dairy India Publ., Delhi.
3. De S. 1980. Outlines of Dairy Technology. Oxford Univ. Press Publ., New Delhi.
4. Gould GW. 1995. New Methods of Food Preservation. Blackie.
5. NDRI. 1998. Advances in Traditional Dairy Products. Lecture Compendium, Dairy Technology Division, NDRI, Karnal.
6. NDRI. 2006. Developments in Traditional Dairy Products. Lecture Compendium, Dairy Technology Division, NDRI, Karnal.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	1	1	1	2	2	2	1	1	2	1	1	2	2	2	2
CO2	3	3	2	3	1	2	2	2	1	2	1	3	2	1	2
CO3	3	2	2	2	1	2	1	2	1	1	1	3	3	1	3
CO4	3	3	2	3	2	1	2	1	2	2	1	2	2	1	2
CO5	1	3	2	2	1	2	1	1	2	2	2	3	2	2	1
Avg	2.2	2.4	1.8	2.4	1.4	1.8	1.4	1.4	1.6	1.6	1.2	2.6	2.2	1.4	2

- 1-low, 2-medium, 3-high, ‘-’- no correlation. Note: The average value of this course is to be used for the program articulation matrix.

OBJECTIVES

- To familiarize the concepts of quality control and safety management in dairy processing.
- To impart knowledge on the microbiological risk analysis specific to dairy products.
- To explain the role of biosensors in the quality control of dairy industry.
- To brief the dairy plant and equipment hygiene practices.

UNIT I INTRODUCTION**9**

Consumer Awareness about Microbiological Quality and Safety of Dairy Foods: Changing scenario; Concepts of quality control, quality assurance, and food safety; Global quality and food safety standards, integrated food law, its main features, and functions.

UNIT II FOOD SAFETY MANAGEMENT SYSTEM IN DAIRY INDUSTRY**9**

Introduction to Food Safety Management System: Concepts of Quality Management System (QMS)– ISO: 9000:2000; Principles of QMS; Standard requirements for QMS; HACCP concept and principle with special reference to biological hazards in dairy foods, TQM tools, and techniques.

UNIT III MICROBIOLOGICAL RISK ANALYSIS**9**

Risk assessment, risk management, and risk communication; risk profiling of dairy products; Microbiological criteria and two and three-class sampling plan/guidelines; Bio-safety concepts in handling dairy pathogens and setting up a microbiological/ pathogen lab in a dairy plant. Rapid Enumeration Techniques: Enumeration principles and procedure for rapid detection of predominant hygiene indicator organisms and pathogens like E. coli (E. coli 0157:H7), Salmonella, Shigella, Staphylococcus aureus, Bacillus cereus, and Listeria monocytogenes.

UNIT IV BIOSENSORS IN DAIRY QUALITY ANALYSIS**9**

Role of Biosensors for monitoring hygiene and safety of dairy foods: Detection of antibiotic residues in milk – Delvo SP, MDR test, penzyme test, charm assay, lateral flow assay (ROSA test), etc. Detection of aflatoxins, pesticides other inhibitors, etc., and their public health importance in dairy foods.

UNIT V PLANT AND EQUIPMENT HYGIENE**9**

Concepts of hygiene and sanitation, microbial quality of water and environmental hygiene in the dairy plant, chlorination of dairy water supply, quality of air, personnel hygiene, treatment and disposal of wastewater and effluents.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO 1 Understand the concepts of quality control and safety management in dairy processing

CO 2 Analyse and carry out a microbiological risk analysis of dairy products

CO 3 Analyse and conceive the role of biosensors in the quality control of the dairy industry.

CO4 Apply the dairy plant and equipment hygiene practices.

CO5 Evaluate the impact of different processing techniques on the nutritional and sensory properties of dairy products.

TEXTBOOKS

1. Griffiths, M. ed., 2010. Improving the safety and quality of milk: Milk production and processing. Elsevier.
2. Motarjemi, Y., Moy, G.G., Jooste, P.J. and Anelich, L.E., 2013. Food Safety Management: Chapter 5, Milk and Dairy Products.
3. World Bank, 2020. Food Safety Handbook: A Practical Guide for Building a Robust Food Safety Management System. The World Bank.
4. Papademas, P. ed., 2014. Dairy Microbiology: A Practical Approach. CRC Press.
5. Gandhi, K., Sharma, R., Gautam, P.B. and Mann, B., 2020. Chemical quality assurance of milk and milk products. Singapore: Springer.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	1	1	2	3	3	3	2	3	1	1	1	1
CO2	2	2	1	1	3	2	1	2	1	1	1	2	2	3	2
CO3	2	3	2	1	2	1	2	1	2	2	1	2	2	2	2
CO4	2	2	3	1	2	2	2	1	2	2	3	1	2	1	3
CO5	2	1	2	1	1	1	1	2	2	1	1	2	2	2	2
Avg	1.8	2	2	1	1.8	1.6	1.8	1.8	2	1.6	1.8	1.6	1.8	1.8	2

- 1-low, 2-medium, 3-high, '-' - no correlation. Note: The average value of this course is to be used for the program articulation matrix.

OBJECTIVES:

- To introduce the basics of fermentation for plant based ingredients.
- To give insights on precision fermentation

UNIT I FERMENTATION BASICS**9**

Fermentative products - enzymes, flavoring agents, vitamins, natural pigments, and fats. Benefits of precision fermentation based dairy alternatives over plant based dairy alternatives

UNIT II DAIRY & FERMENTED DAIRY PRODUCTS**9**

Dairy products, texture, physico-chemical property, functional properties, Probiotic delivering ability, Sensorial features, geography-specific dairy products.

UNIT III CRITICAL CONSIDERATIONS IN PRECISION FERMENTATION**9**

Critical considerations in precision fermentation, Target selection and design, strain development, feedstock optimization strategies, Applications of food bio-informatics, AI, ML for food ingredient discovery, and bio-mimicry strategies in precision fermentation.

UNIT IV PRE-REQUISITES IN PRECISION FERMENTATION**9**

Bioprocess design, feed stock identification for commercial application, Safety and standard regulations, Regulatory approval bodies, Ethical considerations.

UNIT V PRECISION FERMENTATION PRODUCTS AND APPLICATION IN ALTERNATE DAIRY PRODUCT DEVELOPMENTS**9**

Chymosin, Vitamin B12, Riboflavin, Whey protein, casein, collagen, fibronectin, soy leghemoglobin, DHA, EPA, Microbial exopolysaccharides. Dairy analogues, Benefits of dairy analogues over conventional dairy products, Need for dairy alternates.

TOTAL:45 PERIODS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

- CO 1** Understand the concepts, principles and procedures involved in the fermentation of plant based products.
- CO 2** Acquire knowledge on fermented dairy products
- CO 3** Appreciate precision fermentation technology.
- CO 4** Evaluate Critical Considerations in Precision Fermentation
- CO 5** Apply Precision Fermentation in Dairy Alternatives

TEXTBOOKS

1. Microbiology and Technology of Fermented Foods by Robert W. Hutkins, Blackwell Publishing TP371.44 .H88 2006eb ebook.
2. Wood, Brian J. B. "Microbiology of Fermented Foods" Volume 1 and 2. II Edition. Blackie Academic and Professional, 1998.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	1	2	2	2	2	3	3	2	3	1	2	1
CO2	2	2	2	1	3	2	2	2	1	2	1	2	3	2	2
CO3	2	2	2	2	1	1	2	1	2	2	1	2	2	2	3
CO4	2	3	3	1	1	2	2	1	1	3	2	1	1	1	2
CO5	2	1	1	2	2	2	2	2	2	3	2	2	2	1	3
Avg	1.8	1.8	2	1.4	1.8	1.8	2	1.6	1.8	2.6	1.6	2	1.8	1.6	2.2

- 1-low, 2-medium, 3-high, ‘ - ‘ - no correlation. Note: The average value of this course is to be used for the program articulation matrix.

OBJECTIVES

- To impart knowledge on different types of cheese production
- To provide insight into both pre and post-coagulation techniques in cheese production.
- To impart knowledge about the cheese ripening metabolism

UNIT I INTRODUCTION**9**

Introduction – origin of cheese production, scope & status of cheese manufacturing in India, types of cheese, milk, and starter culture quality in cheese production. Additives used in cheese processing. Nutritional aspects of cheese.

UNIT II PRETREATMENT OF CHEESE MILK**9**

Introduction Acidification, Enzymatic coagulation process, Acid/ heat-coagulation process, factor affecting coagulation, post-coagulation techniques – membrane filtration, ultrafiltration techniques and their applications.

UNIT III CHEESE RIPENING CHEMISTRY**9**

Introduction – Ripening agents, Metabolism of residual lactose, lactate, & citrate. Citrate metabolism. Lipolysis, Proteolysis, Catabolism of amino acids and their functions. Cheese Flavor – development of cheese flavor, Accelerated cheese ripening Aroma compounds in specific cheeses.

UNIT IV CHEESE PRODUCTION**9**

Manufacture of Mozzarella, Cheddar, Gouda, Swiss, Cottage, Blue, & Processed cheese, cheese spread and processed cheese foods. Cheese from different milk sources – goat, Ewe, buffalo. Mechanization and automation in cheese processing.

UNIT V MICROBIAL PATHOGEN AND MYCOTOXIN IN CHEESE**9**

Introduction – growth and survival of bacterial pathogens, Production of toxins in cheese, growth and survival of mold. Factor influencing the microbial spoilage of cheese. control measure for microbial contamination in cheese.

TOTAL:45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO1: Understand the fundamentals of cheese production

CO2: Explore the chemistry behind cheese ripening.

CO3: Analyse the master pre-treatment techniques for cheese milk.

CO4: Understand about the microbial pathogen risk in cheese production.

CO5: Gain practical skills in cheese production.

TEXTBOOKS

1. McSweeney, P. L. H., Guinee, T. P., Fox, P. F., Cogan, T. M., McSweeney, P. L. H., Guinee, T. P., Fox, P. F., Cogan, T. M. (n.d.). Fundamentals of Cheese Science. United States: Springer US.
2. Handbook of Cheese in Health: Production, Nutrition, and Medical Sciences. (2013). Netherlands: Wageningen Academic Publishers.
3. Cheese: Chemistry, Physics and Microbiology. (2017). United Kingdom: Elsevier Science.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	3	2	3	1	1	2	1	2	1
CO2	1	1	1	2	3	2	1	2	1	2	1	1	3	3	2
CO3	2	3	2	1	2	1	2	1	2	2	1	2	2	2	2
CO4	3	1	3	2	2	2	2	1	2	3	3	1	2	1	3
CO5	2	2	1	2	1	1	1	2	2	1	1	2	2	2	3
Avg	1.8	1.8	1.8	1.6	2	1.4	1.8	1.6	2	1.8	1.4	1.6	2	2	2.2

- 1-low, 2-medium, 3-high, '-' - no correlation. Note: The average value of this course is to be used for the program articulation matrix.

UNIT I EVAPORATION & MIXING**9**

Basic principles of evaporators, construction and operation, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Basic concepts of multiple effect evaporators, Operations and various feeding systems, Economy of operation, Thermo processor and MVR system, Care and maintenance of evaporators.

Mixing and agitation: Theory and purpose of mixing. Equipments used for mixing solids, liquids and gases. Different types of stirrers, paddles and agitators. Power consumption of mixer-impeller, selection of mixing equipment in dairy industry, mixing pumps.

UNIT II DRYING**9**

Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying-constant and falling rate, Effect of Shrinkage, Classification of dryers-spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems. Factors affecting bulk density of power, spray dryer controls, Theory of solid gas separation, cyclone separators, Bag Filters, Care and Maintenance of drum and spray dryers. Fluidization: Mechanisms of fluidization characteristics of gas-fluidization systems, Minimum Porosity, Bed Weight, Pressure drop in fluidized bed, Application of fluidization in drying, Batch fluidization, Fluidized bed dryers.

UNIT III PROCESSING EQUIPMENTS**9**

Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheese making equipments. Packaging equipments: Packaging machines for milk & milk products. Membrane Processing: Ultra filtration, Reverse Osmosis and electro dialysis, Materials for membrane construction, Ultra filtration of milk, Effect of milk constituents on operation, membranes for electro-dialysis.

UNIT IV MECHANICAL SEPARATION**9**

Fundamentals involved in separation. Sedimentation, Principles involved in filtration, Types, rates of filtration, pressure drop calculations. Gravity setting, principles of centrifugal separation, different types of centrifuges. Application in Dairy Industry, clarifiers, tri processors, cream separator, self-desludging centrifuge, cold and hot separators, Bactofuge, in-line standardization system, care and maintenance of separators and clarifiers. Homogenization: Classification, single stage and two stage homogenizer pumps, power requirement, care and maintenance of homogenizers, aseptic homogenizers.

UNIT V THERMAL PROCESSING**9**

Pasteurization:Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers. Sterilization: Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment. Care and maintenance of Sterilizers. Packaging machines: Pouch filling machine pre-pack and aseptic filling bulk handling system Principles and working of different types of bottle filters and capping machine, Blow molding machines, Aseptic PET bottle filling machine. Cup filling system. Care and maintenance.

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

At the end of the course the students will be able to

CO1 Understand the basic concepts of Nutritional Fortification.

CO2 Describe and demonstrate food safety measures and higher standard of hygiene.

CO3 Learn the specific processing techniques to achieve desired textures, flavors, and nutritional profiles.

CO4 Design storage for dairy products

CO5 Summarize the processing facilitates the distribution and availability of dairy products

TEXTBOOKS

1. Chandan, R. C., & Kilara, A. (Eds.). (2017). Dairy Processing and Quality Assurance. John Wiley & Sons.
2. Singh, H., & Creamer, L. K. (Eds.). (2017). Encyclopedia of Dairy Sciences (2nd ed.). Academic Press.
3. Chandan, R. C., & Kilara, A. (Eds.). (2015). Manufacturing Yogurt and Fermented Milks. John Wiley & Sons.

REFERENCE BOOKS

1. Tamime, A. Y., & Robinson, R. K. (Eds.). (2007). Tamime and Robinson's Yoghurt: Science and Technology. Woodhead Publishing Series in Food Science, Technology and Nutrition. Woodhead Publishing.
2. Walstra, P., Wouters, J. T. M., & Geurts, T. J. (2006). Dairy Science and Technology (2nd ed.). CRC Press.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	2	1	-	1	-	2	-	-	2	3	2	3
CO2	3	2	3	3	2	1	1	-	1	-	1	2	3	2	3
CO3	2	2	3	2	3	-	-	-	-	-	-	3	3	3	3
CO4	3	2	3	3	3	1	2	-	3	-	1	3	3	3	3
CO5	2	2	3	2	2	1	1	-	3	-	1	3	3	3	3
Avg	2.6	1.8	3	2.4	2.2	0.6	1.25	-	2.25	-	1.00	2.60	3.00	2.60	3.00

- 1-low, 2-medium, 3-high, '-' - no correlation. Note: The average value of this course is to be used for the program articulation matrix.

UNIT I INTRODUCTION**9**

Importance of Packaging, History of Package Development, Packaging materials, Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches, Package forms, Legal requirements of packaging materials and product information.

UNIT II**9**

working principles of various type batch type filling machine, working principles of FFS machine, Identification of packaging materials; Flame Hot wire test, Testing of papers/ paperboards: Percentage moisture, Grease resistance, Water absorptiveness, Grammage, Tearing resistance, Bursting strength, Testing of glass bottle – resistance to thermal shock, Testing of plastics and laminates – Thickness, Water vapour transmission rate (WVTR), Grease resistance

UNIT III**9**

Packaging of milk and dairy products such as pasteurized milk, UHT-sterilized milk, aseptic packaging, fat rich products-ghee and butter, coagulated and desiccated indigenous dairy products and their sweetmeades, concentrated and dried milks including baby foods. Packaging of functional dairy/food products.

UNIT IV**9**

Modern Packaging Techniques; Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Principles and methods of package sterilization, Coding and Labelling of Food packages, Aseptic Packaging (AP), Scope of AP and pre-requisite conditions for AP, Description of equipments (including aseptic tank) and machines- Micro-processor controlled systems employed for AP, Package conditions and quality assurance aspects of AP

UNIT V**9**

Microbiological aspects of packaging materials. Disposal of waste package materials, Packaging Systems. Hazards from packaging materials in food.

TOTAL: 45 HOURS**COURSE OUTCOMES(COs):**

CO1 Understand the Fundamentals of Packaging of dairy products.

CO2 Evaluate the Packaging Materials.

CO3 Apply Packaging Techniques in Food Industry.

CO4 Assess Quality and Safety Aspects of packaging.

CO5 Comply with Legal and Regulatory Requirements.

TEXTBOOKS

1. Patel, H.G., Modha, H. and Ranganadham, M. , Packaging of dairy Products, Agrimoon.com
2. Ahvenainen, R. (2003). Novel Food Packaging Techniques. Woodhead Publ. Ltd., Cambridge, England.
3. Engineers India Research Institute. (2005). Handbook of Packaging Technology. EIRI, Delhi.
4. Han, J. (2005). Innovations in Food Packaging. Elsevier Science & Technology Books.
5. Yam, K. L. (2009). Encyclopedia of Packaging Technology. 3rded. John Wiley and Sons, Inc. Publ., USA.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	1	2	1	3	2	3	1	2	2	1	1	1
CO2	2	1	2	3	3	2	2	2	1	2	1	2	3	3	2
CO3	1	2	2	1	2	1	2	1	2	2	1	2	2	2	1
CO4	2	1	3	2	2	2	2	1	1	3	3	1	2	1	3
CO5	1	1	1	2	1	2	1	2	2	1	2	2	2	1	3
Avg	1.8	1.8	1.8	1.6	2	1.4	1.8	1.6	2	1.8	1.4	2	2	2	2.4

- 1-low, 2-medium, 3-high, '-' - no correlation. Note: The average value of this course is to be used for the program articulation matrix.

UNIT I INTRODUCTION TO MEAT PRODUCTS 9

Scope of meat & meat products industry in India, Sources of meat and meat products in India, its importance in national economy; Effect of feed, breed and management on meat production and quality

UNIT II INTRODUCTION TO POULTRY 9

Definition of Poultry, Importance of Poultry Farming, and Poultry development in India. Present status and future prospectus of poultry Industry. Origin of the chicken and Classification of Poultry based on Genetics utility. Classification of chicken as per international standards. Commonly Occurring Anti-Nutrients, and Antibiotics in Poultry Feed Ingredients and its Effect on Egg and Meat Nutrition.

UNIT III INTRODUCTION TO SEA FOODS 9

Introduction, Marine species, Aquaculture, Seafood spoilage, Seafood hazards, Pre-mortem handling, Post-mortem handling.

UNIT IV SLAUGHTERING OF ANIMALS AND POULTRY 9

Common and commercially important meats; pre and post slaughter handling, meat inspection and grading; animal welfare and safety in slaughter plant; Factors affecting post-mortem changes, properties and shelf-life of meat; Meat quality evaluation; Mechanical deboning, meat tenderization.

UNIT V RECENT TRENDS IN MEAT PROCESSING 9

Precision Meat Processing: Technologies for customized product creation. Smart Sensors and IoT: Real-time monitoring and control improvements. Advanced Packaging: Innovations in extending shelf life and reducing spoilage. Integration of AI: Role of artificial intelligence in processing and quality control. Color, flavors, microbiology and spoilage factors of meat and meat products.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course the students would have the knowledge to

CO1 Understand different variety of meats and its handling.

CO2 Familiarize with the concept of meat processing.

CO3 Get insights into basics of marine food processing.

CO4 Understand the basics of poultry processing.

CO5 Discuss egg processing and its related aspects.

TEXT BOOKS

1. Govindan. T.K, —Fish Processing Technology, Oxford and IBH Publishers, New Delhi, 1985.
2. Lawrie, R.A. —Meat Science, Second Edition. Pergamon Press, Oxford, UK. 1975.
3. Stadelmen, W.J. and Cotterill, O.J., —Egg Science and Technology , Second Edition, AVI, Westport, 1977.

REFERENCES

1. Joseph Kerry, John Kerry and David Ledwood. —Meat Processing , Woodhead Publishing Limited, England (CRC Press), 2002.
2. Mead, G. —Poultry Meat Processing and Quality, Woodhead Publishing, England, 2004.
3. Wheaton, F.W. and Lawson, T.B., —Processing of Aquatic Food Products, John Wiley & Sons Publishers, New York. 1985.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	2	2	2	2	2	2	1	1	2	2	1	2	2	1	2
CO2	3	1	2	1	1	3	2	2	2	1	1	3	2	1	2
CO3	1	1	2	1	1	3	1	1	2	1	2	3	1	2	3
CO4	1	2	2	2	2	2	2	1	1	2	1	2	2	1	2
CO5	2	2	3	2	2	2	2	2	2	1	1	2	2	1	2
Avg	1.8	1.6	2.2	1.6	1.6	2.4	1.6	1.4	1.8	1.4	1.2	2.4	1.8	1.2	2.2

- 1-low, 2-medium, 3-high, '-' no correlation. Note: The average value of this course to be used for the program articulation matrix.

UNIT I INTRODUCTION**9**

Definition of muscle and Composition of muscle. Different types of stunning methods. Different types of slaughtering methods, Chemical and biochemical constitution of muscle - Factors reflected in specialized muscle function and constitution, The conversion of muscle to meat - Death of the anima, ageing. Types and characteristics of poultry products, composition, nutritive value, calculation of nutritive value of poultry products, Poultry Meat Tenderness, Pale, Soft, and Exudative Poultry Meat. Poultry dressing - ante and postmortem examination. Transportation to slaughterhouse.

UNIT II SLAUGHTERING AND CUTTING**9**

MEAT: Basic preparatory procedures (culmination, emulsification, pre-blending). Cured and smoked meats. modern abattoirs, Abattoir – Definition and construction. Slaughter house and its features. Animal Handling and Welfare - Humane treatment during handling and transportation, Slaughtering Methods, stunning techniques (electrical, mechanical, gas) and bleeding processes, initial Carcass Handling, Evisceration and quality inspection, Carcass Splitting and Boning, cutting and Fabrication,

POULTRY: Slaughterhouse Building and Facility Requirements, Slaughtering Equipment and Operations, Poultry Carcass Evaluation and Cutting, Official Control of Slaughterhouses and Processing Plants, Poultry Packaging, Food Production from the Halal Perspective.

UNIT III DIVERSIFIED POULTRY**9**

Ducks and Geese – Introduction, Advantages, classification, Ducks rearing system; Quails – Origin and domestication, Advantages of Quail farming; Guinea fowls – Varieties and importance of Guinea fowl farming in India; Turkeys – Turkey farming in India, Varieties.

UNIT IV SPOILAGE AND TEST METHODS OF MEAT**9**

Colour, microbiology and spoilage factors of meat and meat products, Factors affecting post-mortem changes, properties and shelf-life of meat. The spoilage of meat by infecting organisms – TEST METHODS: Physical, Chemical and microbiological testing of meat, Sensory evaluation

UNIT V EGGS**9**

Structure, composition, nutritive value, calculation of nutritive value and functional properties of eggs, Reasons for dirty eggs Remedies, Nutritional and Health Attributes of Eggs, Functional Properties of Egg Components in Food Systems; Estimation of External and Internal Quality of Chicken Egg Factors affecting the quality of Eggs.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course the students will be able to,

CO1 Understand and identify the specific processing technologies used for meat and poultry products.

CO2 Familiarize with quality evaluation techniques for meat and poultry products.

CO3 Grasp the changes in the composition of foods with respect to the type of processing technology used.

CO4 Manage the production and quality of feed and breed.

CO5 Understand the detailed process flow of value added products from poultry species.

TEXT BOOKS

1. Govindan. T.K, —Fish Processing Technology, Oxford and IBH Publishers, New Delhi,1985.
2. Lawrie, R.A. —Meat Science, Second Edition. Pergamon Press, Oxford, UK. 1975.

3. Isabel Guerrero- Legarreta, "Handbook of Poultry Science and Technology", Wiley, 2010.
4. Jhari Sahoo, "Textbook on Meat, Poultry and Fish technology", Daya Publishing House, 2016.

REFERENCES

1. Joseph Kerry, John Kerry and David Ledwood. —Meat ProcessingII, Woodhead Publishing Limited, England (CRC Press), 2002.
2. Mead, G. —Poultry Meat Processing and Quality, Woodhead Publishing, England, 2004.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	2	1	1	1	2	1	2	2	2	2
CO2	3	1	2	1	2	3	2	2	2	2	1	3	3	2	3
CO3	1	1	2	1	1	3	1	2	3	1	2	3	2	3	2
CO4	1	2	2	2	1	2	2	1	1	2	1	2	2	1	2
CO5	2	2	3	2	2	2	2	1	1	1	1	2	2	1	1
Avg	1.8	1.6	2.2	1.6	1.4	2.4	1.6	1.4	1.6	1.6	1.2	2.4	2.2	1.8	2

- 1-low, 2-medium, 3-high, '-' no correlation. Note: The average value of this course to be used for the program articulation matrix.

FT23010 BYPRODUCTS IN MEAT, POULTRY AND FISH PROCESSING L T P C

3 0 0 3

UNIT I MEAT PRODUCTS 9

Flavours and Flavour Generation of Meat Products, Dried and Cured meat. Canned meat, Frozen meat, Cooked and Refrigerated meat, Meat Fermentation, Developments in Meat Bacterial Starters. By product utilization in meat industries.

UNIT II FISH BY PRODUCT 9

Fish byproducts - production of fish meal, collagen and gelatin extraction, fish protein hydrolyzate, fish liver oil and fish silage; Production of chitin, chitosan; Production of non-food items from fish processing wastes. Fishery by-products - Surimi- Introduction, fish muscle proteins, the surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi and fish mince products. Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysis (FPH)

UNIT III EGG PRODUCTS 9

Physical and Chemical changes in the stored Egg — Shelf life duration; Functional Properties of Egg; Egg Products — Egg Powder — Liquid Eggs — Restaurant Products; Industrial use of Eggs and Egg Products.

UNIT IV INGREDIENTS: PAST & FUTURE ROLE IN PROCESSED MEAT MANUFACTURE 9

PAST ROLE: Scientific modelling of blended meat products; Blood by-products as ingredients in processed meat, Utilisation of hydrocolloids in processed meat systems, Use of cold-set binders in meat systems.

FUTURE ROLE: Using natural and novel antimicrobials to improve the safety and shelf-life stability of processed meat products, The use of nutraceuticals in processed meat products and their effects on product quality, safety and acceptability Use of probiotics and prebiotics in meat products.

UNIT V MEAT ALTERNATIVES 9

History of meat alternatives, Texturized proteins, Market for meat alternatives, Meat alternatives health benefits.

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

At the end of the course the students would have the knowledge to

CO1 Understand the Production and Utilization of Meat Products

CO2 Analyze Fish Byproducts and Non-Food Production.

CO3 Evaluate Egg Products and their Functional Properties.

CO4 Examine Ingredients in Processed Meat Manufacturing.

CO5 Understand and Critically Assess Meat Alternatives

TEXT BOOKS

1. Govindan. T.K, —Fish Processing Technology, Oxford and IBH Publishers, New Delhi, 1985.

2. Lawrie, R.A. —Meat Science, Second Edition. Pergamon Press, Oxford, UK. 1975.

3. Stadelmen, W.J. and Cotterill, O.J., —Egg Science and Technology , Second Edition, AVI, Westport, 1977.

REFERENCES

1. Joseph Kerry, John Kerry and David Ledwood. —Meat Processing, Woodhead Publishing Limited, England (CRC Press), 2002.
2. Mead, G. —Poultry Meat Processing and Quality, Woodhead Publishing, England, 2004.
3. Wheaton, F.W. and Lawson, T.B., —Processing of Aquatic Food Products, John Wiley & Sons Publishers, New York. 1985.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	1	1	2	2	2	1	1	1	1	1	2	2	1	2
CO 2	3	3	2	3	3	3	2	2	2	1	1	3	2	1	2
CO 3	3	2	2	2	3	3	1	1	1	1	1	3	3	1	3
CO 4	3	3	2	3	3	2	2	2	1	1	1	2	1	1	2
CO 5	1	2	1	3	2	1	1	3	2	2	1	2	2	1	1
Avg	2.4	2.6	1.6	2.6	2.6	2.2	1.4	1.8	1.4	1.2	1	2.4	2	1	2

- 1-low, 2-medium, 3-high, '-' no correlation. Note: The average value of this course to be used for the program articulation matrix.

FT23011 PRESERVATION TECHNOLOGY OF EGGS, MEAT, POULTRY AND SEAFOOD L T P C

3 0 0 3

UNIT I MEAT 9

The storage and preservation of meat: Preservation of meat- chilling, freezing, curing, smoking, canning, dehydration, irradiation, freeze drying, antibiotics, microwave, chemicals. Moisture control, Direct microbial inhibition.

UNIT II FISH 9

Canning - Principles of canning, classification based on pH groupings, effect of heat processing on fish, storage of canned fish, pre-process operations, post process operations, canning operations for specific canned products (Tuna, Mackerel and Sardine).

Curing- Salting, Marinating and Smoking (smoke production, smoke components, quality, safety and nutritive value of smoked fish, processing and equipment, pre-smoking processes, smoking process control) operations.

UNIT III OTHER SEAFOODS 9

Preservation of shrimp and lobsters, methods and regulations critical to maintaining quality and safety. Freezing techniques (blast freezing and cryogenic methods), canning processes (thermal processing and packaging), drying and dehydration (air and freeze drying), salting and brining (concentration and effects), and smoking (cold and hot techniques). Novel technologies - High-Pressure Processing (HPP) and Pulsed Electric Fields (PEF), quality control measures like HACCP and GMP.

UNIT IV POULTRY 9

Biochemical Changes During Onset and Resolution of Rigor Mortis Under Ambient Temperature, Physicochemical Changes During Freezing and Thawing of Poultry Meat, Low-Temperature Storage of Poultry, Engineering Principles of Freezing, Quality of Frozen Poultry, Quality of Refrigerated Poultry, Refrigeration Equipment and Operations, Freezing Equipment and Operations, Refrigeration and Freezing in Industrial Food Facilities (Hospitals, Restaurants, Factories). Heating, Drying, and Chemicals, Irradiation.

UNIT V EGG 9

Preservation of eggs, refrigeration and freezing, thermal processing, dehydration, coating.

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

At the end of the course the students would have the knowledge to

CO1 Comprehensive Understanding of Meat Preservation Techniques

CO2 Expertise in Canning and Curing of Fish.

CO3 Knowledge of Seafood Preservation Techniques and Emerging Technologies.

CO4 Understanding of Poultry Meat Preservation and Quality Management.

CO5 Proficiency in Egg Preservation Techniques.

TEXT BOOKS

1. Govindan. T.K, —Fish Processing Technology, Oxford and IBH Publishers, New Delhi, 1985.

2.Lawrie, R.A. —Meat Science, Second Edition. Pergamon Press, Oxford, UK. 1975.

3. Stadelmen, W.J. and Cotterill, O.J., —Egg Science and Technology, Second Edition, AVI, Westport, 1977.

REFERENCES

1. Joseph Kerry, John Kerry and David Ledwood. —Meat Processing, Woodhead Publishing Limited, England (CRC Press), 2002.
2. Mead, G. —Poultry Meat Processing and Quality, Woodhead Publishing, England, 2004.
3. Wheaton, F.W. and Lawson, T.B., —Processing of Aquatic Food Products, John Wiley & Sons Publishers, New York. 1985.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	2	1	1	2	1	1	2	2	2	2
CO2	3	3	2	3	3	3	2	1	2	2	1	3	2	1	2
CO3	3	2	2	2	3	3	1	2	2	2	1	3	1	2	2
CO4	3	3	2	3	3	2	2	1	3	1	1	2	3	2	1
CO5	3	2	1	2	2	1	2	1	1	2	2	2	1	1	3
Avg	2.8	2.2	1.6	2.4	2.6	2.2	1.6	1.2	2	1.6	1.2	2.4	1.8	1.6	2

- 1-low, 2-medium, 3-high, '-' no correlation. Note: The average value of this course to be used for the program articulation matrix.

UNIT I INTRODUCTION**9**

A history of seafood industry; Types of fish – major cultured species, underutilized fishery species; Composition, Major and minor nutrients present in sea food, nutrient intake recommendations, nutrition labelling for sea food , structure and spoilage factors of fish. Techniques for harvesting fish; Post harvest quality changes, post-harvest losses, methods for assessing and preventing losses.

UNIT II FISH PROCESSING**9**

Post-mortem changes in fish. Handling and transportation of fish. Bacteriology of fish, Shellfish Handling and primary processing ; Chilling of fish, Freezing and Individual quick freezing, Heat processing of Fish; Radiation processing of fish and fish products. Drying - Traditional chimney kiln, modern mechanical fish smoking kiln of fish. Overview on – Crabs, Lobsters, Prawns, Shrimps.

UNIT II FISH FERMENTATION**9**

Introduction to fermentation in Food Technology; ;Lactic Acid Fermentation; Traditional salt/fish fermentation; Classification of fermented fish; Future trends in fish fermentation technology.

UNIT IV FISH WASTE MANAGEMENT**9**

Introduction, Treatment methods – Hydrolysis, Bioremediation, Anaerobic treatment, Filtration/Screening. Uses of fish waste – Animal feed, Biogas, Natural pigments, In food industry, Inputs and outputs in fisheries.

UNIT V SEAWEEDS AND ITS APPLICATION**9**

Introduction to seaweeds, Chemical composition; Saccharification of seaweeds; Lactic Acid fermentation of sea weeds; Applications of fermented products in food; Future prospects of seaweed fermentation.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course the students would have the knowledge to

CO1 Comprehensive Knowledge of Seafood Industry and Nutrition

CO2 Proficiency in Fish Processing Techniques

CO3 Understanding of Fish Fermentation and Future Trends.

CO4 Knowledge of Fish Waste Management.

CO5 Exploration of Seaweeds and Fermentation Applications

TEXTBOOKS:

- 1.Venugopal, V. "Seafood Processing: Adding Value through Quick Freezing, Retort able Packaging and Cook-Chilling & other methods" (Food Science and Technology Vol. 13) , CRC press, 2006.
- 2.Se-Kwon Kim, "Seafood Science-Advances in chemistry, technology and its applications", CRC press, 2015.
- Ioannins S boziaris, "Seafood Processing – Technology, Quality and Safety", Wiley Blakwell, 2014.

COURSE ARTICULATION TABLE

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	2	1	1	2	1	1	2	2	2	2
CO2	3	3	2	3	3	3	2	2	2	1	1	3	2	1	2
CO3	3	2	2	2	3	3	1	2	1	1	1	3	3	2	3
CO4	3	3	2	3	3	2	2	1	2	2	1	2	2	2	2
CO5	1	2	1	1	3	1	2	2	3	2	1	1	2	2	3
Avg	2.4	2.2	1.6	2.2	2.8	2.2	1.6	1.6	2	1.4	1	2.2	2.2	1.8	2.4

- 1-low, 2-medium, 3-high, '-' no correlation. Note: The average value to be used for the program articulation matrix.

UNIT I INTRODUCTION**9**

Introduction, Packaging materials and its functions – Metal containers, Ethylenic and Non – ethylenic Thermoplastic, Package design and packaging equipment's, Packaging safety,

UNIT II PACKAGING OF COOKED MEATS AND MUSCLE BASED PROCESSED FOODS**9**

Cooked meats, Packaging requirements for muscle-based cooked food products, Consumer trends in food packaging, choosing packaging materials for cooked meat products, Packaging materials and forms used on cooked meat and muscle-based, convenience-style food products – Wrapping, Film packing, Tray packing, Vacuum packaging, MAP.

UNIT III PACKAGING OF FISH AND FISHERY PRODUCTS**9**

MAP principles and importance for packaging fresh fish, Non-microbial effects of MAP, Effects of MAP on - fish spoilage, microbial safety of fish products, Application of MAP on fish and fishery products.

UNIT IV PACKAGING OF POULTRY PRODUCTS**9**

Packaging of Egg and Egg Products, Over-wraps, Tray with over-wraps, Shrink film with over-wraps. Vacuum packaging, MAP.

UNIT V TRENDS IN PACKAGING MATERIALS FOR MEAT, FISH AND POULTRY**9**

Over-wrapping / stretch-wrapping, Vacuum packaging, MAP, Boil and steam cooking packaging, Retort sterilized packaging, Smart packaging, Packaging with enclosed free-oxygen scavenging agent – Future trends.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course the students would have the knowledge to

CO1 Understanding of Packaging Materials and Functions

CO2 Proficiency in Packaging Cooked Meats and Muscle-Based Processed Foods.

CO3 Application of MAP Principles in Packaging Fresh Fish and Fishery Products

CO4 Knowledge of Packaging Poultry Products and Eggs.

CO5 Awareness of Trends in Packaging Materials for Meat, Fish, and Poultry

TEXTBOOKS:

1. J.P.Kerry and J.F.Kerry., Processed meats – Improving, safety, nutrition and quality., Woodhead Publishing Limited., 2011.
2. Ioannis S.Boziaris., Seafood Processing – Technology, Quality and Safety. IFST Advances in Food Science, Wiley., 2014.
3. Jhari Sahoo., Textbook on Meat, Poultry and Fish Technology, Astral International Private Limited., 2016.

COURSE ARTICULATION TABLE

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2	1	2	2	2	2	1	2	1	1	1	2	2	2	2
CO2	3	2	2	3	3	3	2	1	2	1	1	3	2	2	1
CO3	3	3	2	2	3	3	1	1	1	1	1	3	1	2	2
CO4	3	2	2	3	2	2	2	2	1	1	1	2	2	2	2
CO5	1	2	1	1	3	1	2	2	1	1	3	2	1	1	1
Avg	2.4	2	1.8	2.2	2.6	2.2	1.6	1.6	1.2	1	1.4	2.4	1.6	1.8	1.6

- 1-low, 2-medium, 3-high, '-' no correlation. Note: The average value to be used for the program articulation matrix.

UNIT I MEAT**9**

Physical Sensors for Quality Control during Processing, Sensory Evaluation of Meat Products, Detection of Chemical Hazards, Microbial Hazards in Foods: Food-Borne Infections and Intoxications, Assessment of Genetically Modified Organisms (GMO) in Meat Products by PCR, HACCP: Hazard Analysis Critical Control Point, Quality Assurance. Effects of feed, breed and environment on production of meat animals and their quality Meat Quality-color, flavor, texture, Water-Holding Capacity(WHC), Emulsification capacity of meat

UNIT II FISH**9**

National and International Regulations, Standards, Quality Control and Marketing of Fish and Fish Products; Grading Standards of Fish; Quality assessment by Chemical, Physical and sensory methods. Risk characterization.

UNIT III SHRIMP AND LOBSTER**9**

Overview of shrimp and lobster and aquaculture, Quality assessment methods for shrimp and lobster, Physical, chemical, and sensory evaluation, grading systems and standards, factors affecting quality harvesting, handling, and storage methods, processing techniques, Microbiological contaminants in shrimp and lobster, pathogens (e.g., Vibrio, Salmonella), testing and control measures

UNIT IV POULTRY**9**

Chemical Residues: Pesticides and Drugs (β -Agonists and Antibiotics), Factors Affecting Microbial Growth in Fresh Poultry, Basic Principles of the HACCP System in the Poultry Industry, HACCP in Poultry Slaughterhouses, Online Inspection Poultry-Related Foodborne Disease, Overview of Poultry Processing and Workers' Safety, Poultry-Processing Industry and eTool. GRADING OF POULTRY MEAT - Grade — I, Grade — II

UNIT V EGGS**9**

The Nutritive value of Eggs after cooking; Quality identification of shell eggs; Factors affecting egg quality and measures of egg quality. Selection of types of Detergents and Sanitizers for controlling Egg Quality and Poultry Products

TOTAL:45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course the students would have the knowledge to

- CO1** Proficiency in Quality Control Techniques for Meat Products.
- CO2** Understanding of Regulations and Quality Control in Fish Products.
- CO3** Quality Assessment and Management in Shrimp and Lobster.
- CO4** Knowledge of Chemical Residues and HACCP in Poultry.
- CO5** Egg Quality Assessment and Sanitation Practices

TEXTBOOKS:

- 1.Govindan. T.K, —Fish Processing Technology, Oxford and IBH Publishers, New Delhi,1985.
- 2.Lawrie, R.A. —Meat Science, Second Edition. Pergamon Press, Oxford, UK. 1975.
- 3.The food safety information handbook by Cynthia A. Robert, 2009

REFERENCES

1. Joseph Kerry, John Kerry and David Ledwood. —Meat ProcessingII, Woodhead Publishing Limited, England (CRC Press), 2002.
2. Mead, G. —Poultry Meat Processing and Quality, Woodhead Publishing, England, 2004
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	2	1	2	2	1	2	2	2	2	2
CO2	3	3	2	3	2	3	2	1	2	1	2	2	2	2	2
CO3	2	2	3	2	1	3	1	2	1	2	1	3	3	2	3
CO4	3	3	2	3	2	2	2	2	1	2	2	2	2	2	2
CO5	2	1	2	2	1	1	1	2	2	3	1	1	2	1	1
Avg	2.4	2	2	2.4	1.4	2.2	1.4	1.8	1.6	1.8	1.6	2	2.2	1.8	2

- 1-low, 2-medium, 3-high, '-' no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The course aims to:

- Create awareness about the processing of major cereals and pulses.
- Provide knowledge on milling processes and fractionation technologies.

UNIT I PROCESSING METHODS**9**

Overview, Concepts of primary, secondary, and tertiary processing. Milling Techniques, Dry and wet milling, Detailed processes for rice, wheat, maize, and millet. Specific methods: Dry milling: Wheat and rye. Pearling: Rice, oat, and barley. Wet milling: Corn and wheat, Malting: Barley, corn, and wheat.

UNIT II RICE PROCESSING**9**

Paddy Processing and Rice Milling, Conventional vs. modern milling, milling operations, machines, and efficiency, Quality Characteristics, Factors influencing the quality of milled products, Modern Rice Milling Unit Operations, Dehusking, paddy separating, polishing, and grading, Factors affecting rice yield during milling.

UNIT III CORN PROCESSING**9**

Corn Milling Techniques, Dry and wet milling, Starch and gluten separation, milling fractions and modified starches, Process Assessment, Criteria for evaluating milling processes.

UNIT IV WHEAT PROCESSING**9**

Wheat Milling Process, Flour milling, including soft and durum wheat processing, Legume Milling, Home scale, cottage scale, and modern methods, Quality, efficiency, and challenges in dhal milling.

UNIT V PULSE MILLING**9**

Need for Pulse Milling, Unit operations in pulse milling, Domestic and commercial scale methods, Milling Techniques, Dry and wet milling, Improved milling methods, Pulse Milling Machinery, Dehusking, pulse pearling, and splitting, Mini dhal mill: Working principles, advantages, and disadvantages, milling efficiency and grinding of split pulses, Cereal Bran Fractionation, Techniques for recovering functional components and their applications in the food industry.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

By the end of the course, students will be able to:

CO1 Understand paddy processing and rice milling equipment.

CO2 Study corn and wheat processing and milling, promoting gainful employment.

CO3 Develop skills required for pulse milling.

CO4 Apply knowledge of primary, secondary, and tertiary processing methods for cereals, pulses, and millets.

CO5 Evaluating processing techniques and enhancing entrepreneurial skills.

TEXT BOOKS

1. KM. Sahay and KK. Singh : *Unit Operations of Agricultural Processing*, Vikas Publishing House Pvt Ltd, Delhi, 2014.

2. Chakraverty, A. : *Post Harvest Technology of Cereals, Pulses and Oilseeds*, Oxford and IBH Publishing Co, Calcutta, 2014.

REFERENCE BOOKS

1. Samuel A. Matz : *The Chemistry and Technology of Cereals as Food and Feed*, Chapman and Hall, 1992.
2. Bernard Godon and Claude Willm : *Primary Processing of Cereals*, Berns and Noble Publishers, 1994.
3. Karel Kulp and Joseph P. Pante : *Handbook of Cereal Science and Technology*, Marcel Dekker, USA, 2000.

COURSE ARTICULATION MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2	1	2	2	1	2	1	1	1	2	1	2	2	2	2
CO2	3	2	2	3	2	3	2	2	2	1	1	3	3	3	2
CO3	3	2	3	2	1	3	1	2	1	2	2	3	2	2	3
CO4	3	3	2	3	2	2	2	1	1	2	1	2	2	1	1
CO5	1	2	2	1	2	3	2	2	2	1	2	2	3	3	2
Avg	2.4	2	2.2	2.2	1.6	2.6	1.6	1.6	1.4	1.6	1.4	2.4	2.4	2.2	2

- 1-Low, 2- Medium, 3- high, '- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The course aims to:

- Provide information about the importance of malting and brewing in the food industry.
- Impart knowledge about the changes occurring during the processing of non-alcoholic beverages.

UNIT I INTRODUCTION**9**

Introduction to Malting and Brewing, Definition and historical perspective, Scope and significance in the food processing industry, Raw Materials -Barley, hops, water, yeast, Adjuncts for beer production: maize, rice, millet, wheat, sugar. Brewing Overview, Overview of brewing processes and their significance.

UNIT II BARLEY**9**

Production and Trade Barley production and global trade dynamics, Composition and Structure, Detailed composition and structural characteristics of barley, Malting Process, Preparation and storage of barley, Steeping techniques and germination processes, Enzymatic and chemical changes during malting, Role of gibberellic acid, Techniques and Suitability, Techniques of malting different cereals, Suitability and characteristics for malting and brewing.

UNIT III QUALITY CONTROL**9**

Quality Evaluation, Methods for evaluating malt quality, Characteristics of special malts, Water Quality in Brewing, Importance and treatment of water, Mashing, Methods and changes during mashing, Treatment and properties of cereals used as adjuncts, Complications from different adjunct sources.

UNIT IV APPLICATIONS OF MALT IN FOOD**9**

Food Applications, Uses of malt in baking, infant food, and other products, Brewing Operations, Constituents of hops and brewing adjuncts, Quality aspects of beer: flavor, taste, alcohol content, and chemical constituents.

UNIT V APPLICATIONS OF BREWERY BY PRODUCTS**9**

By Products Utilization, Applications in the food industry, Advantages and disadvantages of malting and brewing technologies, Enzyme Applications, Role and applications of enzymes in the malting process.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

By the end of the course, students will be able to:

CO1 : Understand the technology of production of alcoholic beverages.

CO2 : Gain knowledge about quality control techniques for beverages.

CO3 : Comprehend the applications of the malting process in the food processing industry.

CO4 : Utilize By-products and Enzymes from Brewing Processes

CO5 : Evaluate and Ensure Quality in Brewing

TEXTBOOKS:

1. M.J. Lewis and T.W. Young : *Malting and Brewing Science Vol. I*, Springer Science & Business Media, Germany.
2. M.J. Lewis and T.W. Young : *Malting and Brewing Science Vol. II*, Springer Science & Business Media, Germany.

COURSE ARTICULATION MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2	3	2	2	2	2	1	1	1	2	1	2	2	2	2
CO2	3	3	2	3	3	3	2	3	2	1	2	3	3	3	2
CO3	2	2	3	1	2	3	1	1	2	1	2	3	2	2	2
CO4	1	2	1	3	3	2	2	2	1	2	1	2	1	1	1
CO5	2	1	2	1	3	1	3	2	1	2	2	2	1	2	1
Avg	2	2.2	2	2	2.6	2.2	1.8	1.8	1.4	1.6	1.6	2.4	1.8	2	1.6

- 1-Low, 2- Medium, 3- high, '-no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

- Provide a basic understanding of cereals, oilseeds, and pulses post harvesting.
- Impart knowledge about new technologies in oilseed processing.
- Enable students to implement knowledge about detailed manufacturing technologies of cereals, oilseeds, and pulses used in the food industry.

UNIT I OILSEED AND NUTS**9**

Chemical Composition and Characteristics, Chemical makeup and anti-nutritional factors of oilseeds and nuts, Post-Harvest Technology, Handling, drying, storage, grading, pre-treatments, cleaning, and dehulling, addressing issues in size reduction and flaking.

UNIT II OILSEED PROCESSING**9**

Processing Techniques, Traditional and new technologies in processing sesame, coconut, groundnut, mustard, soybean, sunflower, and safflower, Extraction methods and calculation of extraction efficiency, Modification Processes, Hydrogenation, Interesterification, and dry fractionation, Utilization of Oilseed Meals, Desolventization, refining, degumming, neutralization, bleaching, filtration, and deodorization.

UNIT III PROCESSING OF WHEAT AND RICE**9**

Wheat Processing, Types of wheat, milling processes, flour grades, and treatments, Technology of dough development and macaroni products, Oil Extraction, Mechanical expression techniques: Ghani, power Ghani, rotary, hydraulic press, screw press expellers, filter press, Solvent extraction process, Other Edible Oil Sources, Rice bran and corn germ oil extraction.

UNIT IV PROCESSING OF CEREALS**9**

Corn Processing, Wet and dry milling, cornflakes production, Barley Processing, Milling, malting, and beer processing, Oat Processing, Milling into oatmeal, oat flour, and oat flakes, Other Cereals, Sorghum, pearl millet, and finger millet milling.

UNIT V PROCESSING OF MAIZE**9**

Structure and Composition, Detailed composition and milling methods, Processing Techniques, Pre cleaning, cleaning equipment, degermination, and dehusking, Dry and wet milling flow charts, Milling Products, Flour, semolina, brewer's grits, and their applications.

TOTAL: 45 HOURS**COURSE OUTCOMS (COs):**

CO1 : Understand the structure and composition of cereals, pulses, and oilseeds.

CO2 : Gain knowledge of oil extraction methods from oilseeds.

CO3: Understand Wheat and Rice Processing Technologies

CO4 : Identify suitable equipment for processing cereals, pulses, and oilseeds.

CO5 : Understand and master Maize Processing Techniques

TEXTBOOKS

1. Kent : *Technology of Cereal*, 5th Ed. Pergamon Press, 2003.
2. Chakraborty : *Post Harvest Technology of Cereals, Pulses and Oilseeds*, Revised Ed., Oxford & IBH Publishing Co. Pvt Ltd, 1988.
3. Marshall : *Rice Science and Technology*, Wadsworth Ed., Marcel Dekker, New York, 1994.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	2	2	1	2	2	1	2	1	2	2	1	2
CO2	2	2	2	2	1	1	2	1	2	2	1	3	2	1	2
CO3	2	1	1	1	2	1	1	3	2	1	2	3	3	2	3
CO4	2	2	2	2	3	2	1	1	1	1	1	2	2	2	2
CO5	1	2	2	2	2	2	3	2	2	1	1	2	2	2	2
Avg	1.8	1.6	1.8	1.8	2	1.4	1.8	1.8	1.6	1.4	1.2	2.4	2.2	1.6	2.2

- 1-Low, 2- Medium, 3- high, '-no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

Study by products obtained during processing and their uses, Acquire skills for manufacturing food products, Gain knowledge about future developments in food products.

UNIT I INTRODUCTION 9

Supply Chain of Food Grains, Hydrothermal treatment and by products of cereals and millets, Product Development, Infant foods, fermented products, breakfast cereals (flaked, puffed, expanded, extruded, and shredded products).

UNIT II SPECIALITY OIL PRODUCTS 9

Specialty Products, Margarine, mayonnaise, salad dressing, fat substitutes, lecithin, and GMS. Nutritional Mixes, Protein rich foods and protein enriched cereal food from oilseeds.

UNIT III FOOD APPLICATIONS OF BY PRODUCTS 9

Pulse and Oil Milling By Products, Value addition, packaging, and utilization for high protein products like concentrates and isolates, Processing deoiled cakes into protein concentrates and isolates, textured protein products, and functional protein preparations.

UNIT IV CEREAL, PULSES, AND OILSEEDS TECHNOLOGY 9

Processing Techniques, Rice, pulse, and wheat milling, Oil extraction and bread manufacturing processes, Production of buns, biscuits, cakes, cookies, pasta, tortilla, and innovative products from pulses and oilseeds.

UNIT V UTILIZATION OF BY PRODUCTS 9

Nutritional Value and Applications, Chemical composition, nutritional value, and value addition, Traditional processing techniques (parching, puffing, popping, roasting, frying, flaking, fermentation, extraction), Processed corn products and future developments in products and processes.

TOTAL: 45 HOURS**COURSE OUTCOME(COs):**

- CO1:** Understand the supply chain management of food grains and the principles of hydrothermal treatment and by-products of cereals and millets.
- CO2:** Acquire skills to develop innovative food products, including infant foods, breakfast cereals, and fermented products
- CO3:** Gain knowledge about specialty oil products, including margarine, mayonnaise, fat substitutes, and lecithin, as well as protein-rich foods from oilseeds.
- CO4:** Learn to process and add value to by-products from pulse and oil milling, creating high-protein products and functional protein preparations.
- CO5:** Understand various processing techniques, including rice, pulse, and wheat milling, oil extraction, and the production of baked goods and innovative products from pulses and oilseeds.

TEXTBOOKS

1. N.L. Kent and A.D. Evans : *Technology of Cereals* (4th Edition), Elsevier Science (Pergamon), Oxford, UK, 1994.
2. George E. Inglett : *Maize: Recent Progress in Chemistry and Technology*, Academic Press, London, 1982.
3. Ruth H. Matthews : *Pulses: Chemistry, Technology, and Nutrition*, Marcel Dekker, USA, 2000.
4. Wolf Hamm, Richard J. Hamilton, Gijs Calliauw : *Edible Oil Processing* (2nd Edition), ISBN: 978 1 4443 3684 9, 2013.
5. EIRI Board : *Technology of Oilseeds Processing, Oils & Fats and Refining*, 2011.
6. G. Hoffmann : *The Chemistry and Technology of Edible Oils and Fats and Their High Fat Products*, Academic Press, 2013.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	1	2	1	2	1	2	1	2	2	2	2
CO2	3	3	3	3	1	3	2	2	2	1	1	3	3	1	2
CO3	2	2	2	2	1	2	1	1	1	1	1	3	2	2	2
CO4	3	3	2	3	2	2	2	1	1	1	2	2	1	2	1
CO5	2	1	2	1	2	1	1	2	2	2	1	1	2	1	2
Avg	2.4	2.2	2	2.2	1.4	2	1.4	1.6	1.4	1.4	1.2	2.2	2	1.6	1.8

- 1-Low, 2- Medium, 3- high, '-no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

Impart knowledge on the importance of enrichment and fortification of cereals and oils, Understand the role of micronutrients in human health.

UNIT I INTRODUCTION**9**

Food Fortification, Rationale, methods, advantages, and disadvantages, Large scale food fortification, biofortification, and point of use or home fortification.

UNIT II RICE**9**

Enrichment Methods, Need for enrichment, Methods and processed foods from rice, including breakfast cereals, flakes, puffing, canning, instant rice, and other processed rice products.

UNIT III MAIZE PROCESSING**9**

Machinery and Equipment, Acid and enzyme hydrolysis, Processing for value added products like dextrose and maltodextrin, Food Fortification, Potential of neglected legume and oilseed crops for improving food nutrition security, Protein fortification of corn tortillas with oilseed flours.

UNIT IV BIOFORTIFICATION IN PULSES**9**

Introduction to Bio-fortification, Role of micronutrients in human health, Nutritional composition and health benefits of pulses, Interventions and future challenges in Bio-fortification.

UNIT V FORTIFICATION AND ENRICHMENT APPLICATIONS**9**

Bread Enrichment, Fortified breads using oilseed and nut cakes, Protein fortification of corn tortillas with oilseed flours, Effects on the chemical characteristics of wheat chapatti, Cereal Fortification, Fortification with proteins and amino acids.

TOTAL: 45 HOURS**COURSE OUTCOMES(COs):**

CO1: Understands about food fortification of cereals and its applications.

CO2: Understand the need and methods of food enrichment.

CO3: Improve the nutritional quality of food and provide community health benefits with minimal risk to health.

CO4: Understand the micronutrients of pulses and

CO5: Explore about the Fortification and Enrichment of cereals and pulses and its applications

TEXTBOOKS

1. Umed Singh, C. S. Praharaj, S. S. Singh, N. P. Singh, *Biofortification of Food Crops*, Technology & Engineering, ISBN: 8132227166.
2. De Lamo, B., & Gómez, M. (2018). *Bread Enrichment with Oilseeds: A Review*. Foods, 7(11), 191.

COURSE ARTICULATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2	1	2	2	1	2	2	1	1	2	2	2	2	2	2
CO2	3	3	2	3	2	3	3	2	1	2	3	3	1	1	2
CO3	2	2	3	2	2	3	1	2	1	1	1	3	2	2	1
CO4	3	3	2	3	1	2	2	2	2	1	2	2	3	3	2
CO5	2	1	1	2	3	1	2	1	2	2	1	2	1	2	1
Avg	2.4	2	2	2.4	1.8	2.2	2	1.6	1.4	1.6	1.8	2.4	1.8	2	1.6

- 1-Low, 2- Medium, 3- high, '-no correlation. Note: The average value to be used for the program articulation matrix.

OBJECTIVES

Understand the physicochemical properties of fats and oils, Study the different extraction and refining processes of various fats and oils in food processing industries.

UNIT I PHYSICAL AND CHEMICAL PROPERTIES 9

Introduction to Chemical composition and physicochemical properties of fats and oils, Fatty Acids Functions of oils in the human body, Double bond positions and Geneva type classification, Sources and Production. Vegetable oils: coconut, palm, peanut, rice bran, sesame, mustard, and sunflower seeds, Chemical Reactions, Hydrolysis, hydrogenation, oxidation, and polymerization.

UNIT II EXTRACTION METHODS 9

Mechanical Expression, Ghani, power Ghani, rotary, hydraulic press, screw press, and filter press, Solvent Extraction Process, Steps involved in batch and continuous solvent extraction, Oil quality, standard regulations, shelf life, and oxidative stability.

UNIT III REFINING OF OILS 9

Scope and Importance, Characterization: degumming, DE acidification, bleaching, decolourising, deodorization, and winterization, Hydrogenation of Oil, Selectivity, catalysts, and production of Vanaspati, ghee, and margarine, Fat Replacers, Characterization, types, and specific uses. Processing of Other Edible Oils, Rice bran, maize germ, and others, Sustainability and the nutritional importance.

UNIT IV PHYSIOCHEMICAL PROPERTIES OF FATS AND OILS 9

Properties and Analysis, Instrumental analysis: Gas chromatography, FTIR, GC MS, NMR, and NIR spectroscopy, Edible Use, Applications of fats and oils in the food industry.

UNIT V INDUSTRIAL APPLICATIONS AND QUALITY STANDARDS 9

Manufacture of soap, candles, paints, and varnishes, Quality Regulations, ISI and Agmark standards, Plant Operations, Site selection for oil extraction plants, safety aspects, and HACCP standards in oil industries.

TOTAL: 45 HOURS**COURSE OUTCOMES (Cos):**

At the end of the course, the students will be able to

CO1: Understand the processing technologies used for fats and oils.

CO2: Identify the edible uses of fats and oils in food industries.

CO3: Apply knowledge to the manufacture of designer fats.

CO4: Analyse fatty acid components using various instrumentation.

CO5: Understand the industrial applications and quality standards of oil

TEXTBOOKS:

1. Harry Lawson, *Food Oils and Fats: Technology, Utilization, and Nutrition*, CBS Publishers and Distributors, New Delhi, 1997.
2. Gunstone F.D., *Oils and Fats in Food Industry*, Blackwell Publishing, United Kingdom, ISBN: 9781405171212, 2008.
3. Gunstone F.D., *Vegetable Oils in Food Technology: Composition, Properties, and Uses*, 2nd Edition, Wiley Blackwell Publishing Ltd., ISBN: 9781444332681, 2011.

COURSE ARTICULATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	3	2	2	1	3	2	2	3	2	1	1	1	2
CO2	2	1	1	1	2	2	1	1	1	2	1	2	2	2	1
CO3	2	2	2	2	2	1	3	2	2	2	1	1	2	1	2
CO4	2	1	2	1	2	2	2	3	1	2	2	2	1	1	1
CO5	2	2	1	2	2	1	1	1	3	1	1	1	2	1	2
Avg	2.2	1.6	1.8	1.6	2	1.4	2	1.8	1.8	2	1.4	1.4	1.6	1.2	1.6

- 1-Low, 2- Medium, 3- high,'- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

UNIT I QUALITY CONTROL AND SAFETY IN GRAIN MARKETING**9**

Objectives, importance and functions of quality control, Importance of safety in marketing of grain and grain products - domestic and export markets. International organizations: ISO, CAC, WTO, USFDA, Codex, EIC. National organizations: FSSAI, BIS, CCFS, Agmark and APEDA, Good Laboratory Practices.

UNIT II FOOD SAFETY REGULATIONS AND QUALITY ASSURANCE IN THE FOOD INDUSTRY**9**

Regulations of food safety and quality - Food laws - Food Safety and Standards Act (FSSAI) and standards of foods, Packaged Commodities Rules, QA Audit, HACCP, GMP, standard sanitary procedures- GAP, GFSI; function and roles of USFDA, USDA and EPA, ASTA

UNIT III QUALITY CONTROL MEASURES AND INTERNATIONAL STANDARDS FOR FOOD EXPORT**9**

Quality Control Measures - International standards for export and quarantine requirements for export of food products (raw and processed). Adulteration and its types, sensory and instrumental analysis, rules and regulations for waste disposals. Sampling and specification of raw materials and finished products. Statistical quality

UNIT IV ASSESSING AND MANAGING GRAIN QUALITY**9**

Assessing Grain Quality - Physical Aspects, Variety, Growth and Storage Conditions, Chemical Composition. Managing Grain Quality - Grain Reveal, Segregation and Storage, Processing, Nutrition and Intolerances, Sampling Devices, Human Visual Analysis, Bulk Density (Test Weight), Moisture Content, Sieves and Dockage Tester, Protein Content, Wheat Hardness, ELISA Test Kits for Mycotoxins.

UNIT V ADVANCED TECHNIQUES FOR GRAIN QUALITY ASSESSMENT**9**

Falling Number, NIR Spectroscopy, Digital Imaging, Hyperspectral Imaging, ELISA Test Kits for Insect Activity, PCR-Based Detection Methods, Electronic Noses, X-ray Imaging for Internal Insects.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO1: At the end of the course the students will be able to understand the importance of quality control of grain

CO2: Understand the various national and international laws & regulations involving in grain quality control

CO3: Understand the traditional and new technologies in involving in quality control

CO4: Implement the food laws and regulations of beverages

CO5: Understand the advanced techniques for the grain quality assessment

TEXTBOOKS:

1. Inteaz. A, Food Quality Assurance: Principles and Practices, Taylor and Francis, 2014
2. Andres V J, Quality Assurance for the Food Industry: A Practical Approach, CRC Press, 2004
3. Manoranjan K, Food analysis and Quality control, Kalyani Publishers, 2002
4. David K, Sensory Analysis for Food and Beverage Quality Control: A Practical Guide, Woodhead Publishing Ltd, 2010

COURSE ARTICULATION MATRIX

CO NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	2	2	2	1	1	2	1	1	2	2	1	2
CO2	3	3	2	3	3	3	2	2	2	2	2	3	1	2	3
CO3	2	2	3	1	2	3	1	1	2	1	2	3	2	3	2
CO4	1	2	1	3	3	2	2	2	1	1	1	2	1	2	1
CO5	1	2	2	1	3	2	1	2	2	2	1	1	2	1	1
Avg	1.8	2.4	2	2	2.6	2.4	1.4	1.6	1.8	1.4	1.4	2.2	1.6	1.8	1.8

- 1-Low, 2- Medium, 3- high,' - 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The course aims to

- To develop the knowledge of students in the area of post-harvest processing of various Fruit and vegetable technologies.
- To enable students to appreciate the application of scientific principles in the processing of post-harvesting materials

UNIT I**9**

Overview of post-harvest losses and causes, Classification of fruits & vegetables – tropical, sub-tropical, arid, semi-arid, under and unutilized fruits and vegetables, harvesting of fruit and vegetables – elements of harvest, mechanical, manual – types, harvest aids, extent of mechanization

UNIT II**9**

Structure of plant cell, Structure of fruits and vegetables, texture of fruits and vegetables, texture-structure relationship, maturation and spoilage, ripening and senescence

UNIT III**9**

Composition and nutritional quality – water, protein, fat, carbohydrates, oils, organic acid, minerals, pigments, flavor compounds, and anti-nutritional compounds in fruit and vegetables.

UNIT IV**9**

Quality and maturity indices - aerobic and anaerobic respiration, energy currency – ATP, aerobic oxidation of glucose, biochemical pathways, factors influencing respiration, control measures to minimize respiratory loss, respiration rate quantification, Physical and textural characteristics, structure, and composition. Maturity standards; Importance, methods of Maturity determinations maturity indices for selected fruits and vegetables.

UNIT V**9**

Post-harvest pathology – common diseases, disease development, infection process, defense mechanism, growth behavior of bacteria and fungi, treatment for pathogen control, pre-harvest control, post-harvest treatments, insect control, chilling and freezing injury.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO1: Identify post-harvest losses and harvesting methods.

CO2: Analyze the structure and texture relationship in fruits and vegetables.

CO3: Evaluate the nutritional composition of fruits and vegetables.

CO4: Determine quality and maturity indices, and understand respiration processes.

CO5: Recognize and manage common post-harvest diseases and pathogen control methods.

TEXTBOOKS:

1. Verma, L. R., Joshi, V. K., Verma, L. R., Joshi, V. K. (2000). Postharvest Technology of Fruits and Vegetables: General concepts and principles. India: Indus Publishing Company.
2. Preharvest Modulation of Postharvest Fruit and Vegetable Quality. (2017). United Kingdom: Elsevier Science.
3. Mathur, G. K., Chasta, S. S., Rathore, N. S., Mathur, G. K., Chasta, S. S., Rathore, N. S. (2012). Post-harvest Management and Processing of Fruits and Vegetables. India: Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	3	1	1	2	1	3	3	1	2	2	1	1
CO2	3	2	3	1	2	2	2	1	2	2	2	1	3	2	2
CO3	3	2	2	2	2	1	2	1	2	3	2	2	2	1	2
CO4	2	3	2	1	2	2	2	1	2	1	1	1	2	2	1
CO5	1	1	1	2	2	1	2	2	2	2	2	2	3	1	2
Avg	2.2	2	2	1.8	1.8	1.4	2	1.2	2.2	2.2	1.6	1.6	2.4	1.4	1.6

- 1-Low, 2- Medium, 3- high, '-'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The course aims to

- Develop the knowledge of students in the area of vegetable and fruit processing and technology.
- Enable students to appreciate the application of scientific principles in the processing of fruits and vegetables.

UNIT I BASIC AGRICULTURAL ASPECTS OF VEGETABLES AND FRUITS**8**

Ability to identify all commercially important fruits and vegetables with their names in important Indian languages, important regions, seasons, Production and processing scenario of fruits and vegetables - India and World. Scope of Fruit and Vegetable Preservation Industry in India. Present status, constraints, and prospectus. Problem-solving in post-harvest quality of fruits and vegetables.

UNIT II FRESH FRUITS AND VEGETABLES**8**

Physical and textural characteristics, structure, and composition. Maturity standards; Importance, methods of Maturity determinations maturity indices for selected fruits and vegetables. Harvesting of important fruits and vegetables. Fruit ripening- chemical changes, regulations, methods. Calculation of respiration rates, Spoilage of fruits, vegetable and their processed products.

UNIT III PRESERVATION OF FRUITS AND VEGETABLES**9**

Preservation by fermentation- Definition, Advantages, disadvantages, Types of fermentation, equipment; Fruit wine. Irradiation applications for fruits and vegetables. Minimally processed fruits and vegetables, solving problems with respect to natural resistance of fruit, General pre-processing, drying, and freezing of fruits and vegetables - problems associated with specific fruits and vegetables, problem-solving in post-cutting treatments to extend the shelf-life of fresh-cut products.

UNIT IV CANNING, PUREES, AND JUICES**12**

Canning- General pre-processing, specific or salient points in fruits and vegetables like – Blanching, exhausting, processing conditions; Indian Food Regulation and Quality assurance , Fruit Juice/pulp/ Nectar/Drinks, concentrates – General and specific processing, different packing including aseptic. Indian Food Regulation and Quality Assurance. Vegetable Purees/pastes - General and specific processing, different packing including aseptic. Technology for juice pressing, juice extraction and clarification, methods of bottling, enzymatic clarification and debittering of juices, fruit juice powders- preparation and packaging.

UNIT V FRUIT AND VEGETABLE PRODUCTS**8**

Ready-to-eat fruit and vegetable products, Jams/Marmalades, Squashes/cordials, Ketchup/sauces, Chutneys, Fruit Bar, Soup powders, Candied Fruits, Natural colors, Fruit and Vegetable Fibres- General and specific processing, different packing including aseptic, Dried Onion, Powder. Garlic Dried Garlic, Powder, Oil. Potato Wafer; starch, Papad, Carrot Preserve, candy, Pickle, Jam. Cauliflower and cabbage Dried cauliflower and cabbage, Sauerkraut, Pickle Leafy vegetables; Dried Leafy Vegetables. (Spinach, Fenugreek, Coriander leaves, Curry leaves). Bitter gourd Pickle, Dried bitter gourd. Indian Food Regulation and Quality assurance, Case studies- Improving the nutritional quality of processed fruits and vegetables, Waste management in fruit and vegetable processing industries

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

- CO1:** Identify commercially important fruits and vegetables and understand their production and processing scenarios.
- CO2:** Analyze the physical and chemical changes in fresh fruits and vegetables, including ripening and spoilage processes.
- CO3:** Understand and apply preservation methods like fermentation, irradiation, drying, and freezing for fruits and vegetables.
- CO4:** Understand and apply canning techniques, juice extraction, and quality assurance for fruit and vegetable products.
- CO5:** Process various ready-to-eat fruit and vegetable products and manage waste in the processing industry

TEXTBOOKS:

1. Fellows, P J. "Food Processing Technology Principles and Practice". 3rd Edition, Woodhead, 2009.
2. Salunke, D . K and S. S Kadam "Hand Book of Fruit Science and Technology Production, Composition, Storage and Processing". Marcel Dekker, 2005.
3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2	2	2	3	1	1	2	1	3	3	1	2	2	1	1
CO2	3	2	3	1	2	2	2	1	2	2	2	1	3	2	2
CO3	3	2	2	2	2	1	2	1	2	3	2	2	2	1	2
CO4	2	3	2	1	2	2	2	1	2	1	1	1	2	2	1
CO5	1	1	1	2	2	1	2	2	2	2	2	2	3	1	2
Avg	2.2	2	2	1.8	1.8	1.4	2	1.2	2.2	2.2	1.6	1.6	2.4	1.4	1.6

- 1-Low, 2- Medium, 3- high, '-no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The course aims to

- Familiarize students with advanced fruit and vegetable processing techniques and their applications
- Understand the effect of Novel non-thermal methods on the quality and safety of fruit and vegetable products.

UNIT I 9

Ultraviolet light for processing of fruit and vegetable products, high-pressure processing of fruit and vegetables, ultrasound application of fruit and vegetable products, minimal processing

UNIT II 9

Membrane application in fruit and vegetable processing technologies, high-intensity pulsed electric field applications, applications of ozone in fruit and vegetable processing, irradiation application in fresh fruit and vegetable produce processing

UNIT III 9

Enzyme maceration, fruit and vegetable juices as a vehicle for probiotic microorganism and prebiotics oligosaccharides, vacuum frying of fruit and vegetable application in processing, the role of canning in the preservation of fruits and vegetables,

UNIT IV 9

freeze concentration applications in fruit and vegetable processing, refrigeration, and cold chain effects on fruit and vegetable product shelf life, edible coatings.

UNIT V 9

Thermal treatment effects in fruit and vegetable juices, the effect of fruit and vegetable processing on product aroma, sensory evaluation in fruit and vegetable product development, ohmic heating, microwave dielectric heating recent trends in drying

TOTAL: 45 HOURS

COURSE OUTCOMES (COs) :

At the end of the course, the students will be able to

- CO1:** Understand different non-thermal processing of food and its application in fruit and vegetable processing
- CO2:** Familiarize students with Novel non-thermal methods for sterilization of fruit and vegetable
- CO3:** Understand the effect of Novel non-thermal methods on the quality and safety of fruit and vegetable products.
- CO4:** Evaluate the efficiency and practicality of non-thermal processing techniques in extending the shelf life of fruits and vegetables.
- CO5:** Implement non-thermal processing technologies in the development of innovative fruit and vegetable products.

TEXTBOOKS

1. Advances in Fruit Processing Technologies. (2012). United Kingdom: Taylor & Francis.
2. Technological Interventions in the Processing of Fruits and Vegetables. (2018). United States: Apple Academic Press.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	2	3	3	2	3	2	1	2	2	2
CO2	2	3	2	1	3	2	1	2	3	2	2	2	3	3	2
CO3	2	2	3	1	2	3	2	2	2	3	1	2	2	3	2
CO4	2	2	2	1	2	3	2	2	2	2	3	1	2	2	3
CO5	3	1	3	1	2	2	1	2	2	1	2	2	3	3	2
Avg	2.4	2	2.2	1	2.2	2.4	1.8	2.2	2.2	2.2	2	1.6	2.4	2.6	2.2

- 1-Low, 2- Medium, 3- high, '-no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The course aims to

- Understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- Understand the role of Nutraceuticals and functional food in health and disease

UNIT I**9**

Introduction to major class of bioactive in fruits and vegetables, present scenario of nutraceutical market, food, and nutrient intake behavior in Indians, classification of plant-derived bioactive, the interaction of functional food with medicine, Vitamins, and Minerals of fruits and Vegetables, Flavonoid, Isoflavone, and Carotenoid Contents in Raw fruits and Vegetables, Fibre – dietary fibre, plant tissue and type of cell walls, cell wall polysaccharide, effects of cooking or processing on cell wall composition, health benefits

UNIT II**9**

Pharmacological properties of fruits and vegetables; nutritional indicators and health aspects of fruits and vegetable consumption in adults; diabetes, diabetic complication and flavonoids; curcumin – epigenetic therapy; Nutraceuticals as a therapeutic agent for inflammation – flavonoids, anthocyanin; diet and nutrition in prostate health, Antioxidants in fruits & vegetables – factors that affect antioxidant response to ingestion of fruit - health properties.

UNIT III**9**

Role of fruit and vegetable nutrients in Cancer and immune system enhancer, utilization in functional foods, phytosterol, phytoestrogens, glucosinolates, organosulphur compounds, flavonoids, carotenoids, etc. Sports foods – ingredients, components in sports foods, sports drinks, design consideration, ergogenic aids in sports nutrition. Formulations for meeting the normal and special needs of infants, the current status of infant foods, and additives for infant foods. Foods for aged persons, design consideration, ingredients for geriatric foods

UNIT IV**9**

Concept of new health food product development from fruits and vegetables. Safety; marketing strategy and consumer response; economic analysis and costing of novel foods from fruits and vegetables, Prebiotic substances from fruits and vegetables and their utilization in functional foods, symbiotic foods, technological aspects and recent development in probiotics, prebiotics and symbiotics.

UNIT V**9**

Nutraceutical delivery vehicles, Role of bioactive from fruit and vegetables for human health – plant parts and chemistry, mechanism of action - case studies, recovery of valuable bioactive from residues of fruit and vegetable processing industry, stability and bioaccessibility of fruit and vegetable. Bioactive in food – food component interaction and matrix effect.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs) :**

At the end of the course the students will be able to

CO1: Understand the classification and bioactive components of fruits and vegetables.

CO2: Analyze the health benefits and pharmacological properties of fruits and vegetables.

- CO3:** Evaluate the role of fruit and vegetable nutrients in disease prevention and immune enhancement.
- CO4:** Develop health food products from fruits and vegetables with safety and market considerations.
- CO5:** Understand the stability and delivery mechanisms of bioactive compounds in fruits and vegetables.

TEXTBOOKS

1. Anumala, V., Phurailatpam, A., Sarma, P., Anumala, V., Phurailatpam, A., Sarma, P. (2021). Fruits and Vegetables as Nutraceutical: Nature's Medicine. United States: Taylor & Francis.
2. Functional Foods, Nutraceuticals, and Degenerative Disease Prevention. (2011). Germany: Wiley.
3. Li, T. S. C., Li, T. S. C. (2008). Vegetables and Fruits: Nutritional and Therapeutic Values. United States: CRC Press.
4. Nutritional Composition and Antioxidant Properties of Fruits and Vegetables. (2020). Netherlands: Elsevier Science.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	2	2	2	3	2	3	2	2	1	2
CO2	3	2	1	1	2	2	1	2	1	1	1	1	2	2	2
CO3	3	1	2	1	1	1	1	1	2	2	1	2	2	2	2
CO4	2	1	3	2	2	1	1	1	1	1	2	1	2	2	2
CO5	3	1	1	2	1	2	1	2	2	1	1	1	2	2	2
Avg	2.8	1.4	1.6	1.6	1.4	1.6	1.2	1.6	1.8	1.4	1.6	1.4	2	1.8	2

- 1-Low, 2- Medium, 3- high, '-'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The course aims to

- Understand the different methods involved in the development of fruit and vegetable packaging systems.
- Understand the different packaging systems available for fruit and vegetable packaging.

UNIT I**9**

Bio-based packaging of fruits and vegetables, MAP of fresh produce, shrink packaging of fruits and vegetables, NMBP, antimicrobial packaging – basic concepts and applications in fresh and fresh-cut fruits and vegetables, cushioning materials for fruits and vegetables

UNIT II**9**

Active packaging of fresh and fresh-cut fruits and vegetables, Intelligent packaging applications of fruits and vegetables, Edible coating and their effect on their effect on post-harvest quality of fruits and vegetables, nano-enabled packing of food products

UNIT III**9**

Engineering properties of packaging film for raw and processed fruits and vegetable products, predictive modeling for packaged fruits and vegetables, and mathematical modeling for micro-perforated films in fruit and vegetable packaging.

UNIT IV**9**

Smart packaging technologies for fruit and vegetable beverage products – gas release, flavour release, nutrient release, enzyme release, thermochromic labeling, smart branding, odour removal packaging, anti-counterfeit beverage packaging, tamper-proof packaging.

UNIT V**9**

Improving convenience in product use and for on-the-go food and drink consumption, self-heating and self-cooling systems, smart packaging of fruit and vegetable beverages with aerosol.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs) :**

At the end of the course, the students will be able to

CO1: Understand bio-based, antimicrobial, and MAP packaging methods for fruits and vegetables.

CO2: Analyze active, intelligent, and nano-enabled packaging applications for fresh and fresh-cut produce.

CO3: Evaluate the engineering properties and predictive modeling of packaging films for fruits and vegetables.

CO4: Apply smart packaging technologies for fruit and vegetable beverage products, including thermochromic and anti-counterfeit labeling.

CO5: Develop packaging solutions for improved convenience, such as self-heating, self-cooling, and aerosol systems for on-the-go consumption.

TEXTBOOKS

1. Innovative Packaging of Fruits and Vegetables: Strategies for Safety and Quality Maintenance. (2018). Canada: Apple Academic Press.
2. Innovations in Food Packaging. (2013). Netherlands: Elsevier Science.
3. Packaging and Storage of Fruits and Vegetables: Emerging Trends. (2021). (n.p.): Apple Academic Press.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	3	1	2	2	2	1	2	1	1	3	2	3
CO2	2	2	1	1	2	1	1	2	1	3	1	1	3	2	3
CO3	3	1	1	1	1	1	1	1	2	2	1	1	3	2	3
CO4	1	1	2	2	3	2	2	1	1	1	1	1	3	2	3
CO5	2	1	1	1	1	1	1	2	2	1	1	1	3	2	3
Avg	2.2	1.2	1.4	1.6	1.6	1.4	1.4	1.6	1.4	1.8	1	1	3	2	3

- 1-Low, 2- Medium, 3- high, '-'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES:

- To study various food laws, importance and functions of food safety management systems
- To impart knowledge on food laws and safety in food processing.

UNIT I NECESSITY OF LAW IN FRUIT AND VEGETABLE PROCESSING INDUSTRY**9**

Establishment of the US Pure Food Law in the early 1900s and of the Food & Drug Administration to enforce the safety of food products; Urbanisation of the population and necessity of processed and preserved foods and the necessity of ensuring the quality of food to prevent adulteration. PFA; Various aspects of defining adulteration, taking samples of food for analysis by public analyst, prosecution for adulteration and punishment; Standards of various food products; FPO; Use of permitted additives like colours, preservatives, emulsifiers, stabilisers, antioxidants etc. Food Safety & Standards Act 2006 and the provisions therein; Integrated Food Law - Multi departmental - multilevel to single window control system, consumer protection Act.

UNIT II FOOD SAFETY IN PROCESSING**9**

Fruit and vegetable processing industry - Building and equipment design; microbiological quality of fruit and vegetable products, air; Safety in food procurement, storage, handling, and manufacture; Food safety in retail fruit and vegetable product businesses; international foodservice operators, institutional food service operators; application of the principals of modern hygiene; Food handlers, habits, clothes, illness;

UNIT III KEY SAFETY PRINCIPLES**9**

Fruit and vegetable processing industry - Training & Education for safe methods of handling fruits and vegetables; cleaning and sanitization of processing plants; principles of cleaning and sterilization; sterilization & disinfection- different methods used-detergents, heat, chemicals; selecting and installing equipment; Cleaning of equipment and premises. Safety limits of sanitizers; pest control; management and disposal of waste.

UNIT IV FOOD SAFETY MANAGEMENT SYSTEM**9**

Fruit and vegetable processing industry - Physical, chemical, and Microbial hazards and their control in food industry; Quality systems standards including ISO; - ISO 9000; total quality management (TQM); hazard analysis of critical control points (HACCP); good manufacturing practices (GMP);

UNIT V MANAGEMENT**9**

Good Manufacturing Practice and HACCP; Surveillance networks, Consumer and food service operator education; GM Foods, safety and labeling; International Food Standards ISO 9000 and related standards; Impact of food safety on global trade. Concepts and trends in food legislation, Information-Domination in the European Food Industry, Agriculture, Ethics and Law, WHO in Global Food Safety Governance, The Right to Food in International Law with Case Studies. Intellectual Property and Food Labelling: Trademarks and Geographical Indications, Agricultural Innovation: Patenting and Plant Variety Rights Protection, Cross-Contamination, Genetic Drift, and GMO Co-existence with Non-GM Crops, Legal Barriers to International Food Trade, food policies

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

At the end of the course, the students will be able to

CO1: Identify the agencies responsible for legislation and implementation related to fruit and vegetable packaging.

CO2: Pinpoint relevant legislation and standards for fruit and vegetable-based packaging products.

CO3: Assess and interpret the meaning of relevant legislation concerning fruit and vegetable packaging issues.

CO4: Propose amendments to existing legislation or standards to pertinent authorities when justifiable.

CO5: Understand and apply innovative packaging technologies to improve the shelf-life and quality of fruits and vegetables.

TEXTBOOKS:

1. Rees, Naomi and David Watson —International Standards for Food Safety□, Aspen Publication, 2000.
2. Schmidt, Ronald H. and Rodrick, G.E. —Food Safety Handbook□, Wiley Interscience, UK, 2005.

REFERENCES:

1. Mehta, Rajesh and J. George —Food Safety Regulations, Concerns and Trade : The Developing Country Perspective□, Macmillan, 2005.
2. The Prevention of Food Adulteration Act, 1954□, Commercial Law Publishers India) Pvt. Ltd.,

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	1	1	1	1	2	2	3	1	2	1
CO2	2	2	2	3	2	1	2	1	3	2	1	1	2	2	1
CO3	2	2	2	3	2	1	1	1	2	1	3	2	2	2	1
CO4	2	2	2	3	1	1	1	1	2	2	1	1	2	2	1
CO5	2	2	2	3	1	1	1	1	1	2	2	1	2	2	1
Avg	2	1.8	1.8	2.6	1.4	1	1.2	1	1.8	1.8	1.8	1.6	1.8	2	1

- 1-Low, 2- Medium, 3- high, '-no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The course aims to

- Provide In-depth knowledge on safe storage of food materials.
- Enable design of storage Structures for various categories of food product

UNIT I**9**

Introduction – storage operation, harvest and pre-harvest factors, traditional and modern storage methods, changes during storage, factors influencing storage, genetic effects on storage, humidity and temperature – measurement and control technology, store design and methods, pre-storage treatments

UNIT II**9**

Pre-cooling of fruits and vegetables – methods, estimation of cooling time, ventilation & forced system, combined forced and extraction system, low-cost cold room, storehouse – layout of floor duct, air distribution, packaging icing, cooling load calculations, vacuum cooling – principle, process, mechanism, equipment, advantages, limitations, Commercial forced air cooling methods, product moisture loss and produce a cooling pattern with forced air cooling; heat load; hydro cooling of fruits and vegetables – hydro cooling rate, methods; evaporative cooling (EC) – thermodynamics and psychrometric of EC process, types of EC system, limitations, maintenance and design

UNIT III**9**

Hypobaric storage – mode of action, transport, effect on fruits and vegetables, case studies on raw horticultural commodities and processed products, vacuum infiltration and cooling, hyperbaric storage – mode of action, effect on fruits and vegetables, case studies on raw horticultural commodities and processed products

UNIT IV**9**

Controlled atmosphere (CA) – changes during storage, biochemical considerations, gas exchange mechanism, equipment for producing and regulating CA, design, construction, and operation - on raw horticultural commodities and processed products, gas measurement and control technology, effect of gas atmosphere and interactions, MAP – techniques, polymeric film properties, gas and vapor applied to MA process operation, effect on shelf life of fruits and vegetables, MAP design with O₂ modeling, chilling injury, control of temperature, absorbers

UNIT V**9**

Handling of common fruits and vegetables – recommended storage conditions for various fruits and vegetables, storage and transportation of fruits - citrus, sub-tropical, pears, grapes, plums, cherries, peaches, apricots and berries. Vegetables – artichokes, asparagus, corn, cucumber, eggplant, garlic, lettuce, melon, mushroom, okra, onion, parsnip, parsley, peas, pepper, potato, spinach, canned foods, transport. – sea, CA, hypobaric, MA – case studies.

TOTAL: 45 HOURS**COURSE OUTCOMES(COs):**

At the end of the course the students will be able to

CO1: Understand storage methods and factors affecting fruit and vegetable storage.

CO2: Apply pre-cooling and cooling techniques for effective storage.

CO3: Evaluate hypobaric and hyperbaric storage methods for fruits and vegetables.

CO4: Design controlled atmosphere and modified atmosphere packaging systems.

CO5: Develop storage and handling strategies for various fruits and vegetables.

TEXTBOOKS:

1. Thompson, A. K., Thompson, A. K. (2015). Fruit and Vegetable Storage: Hypobaric, Hyperbaric and

Controlled Atmosphere. Germany: Springer International Publishing.

2. Puttongsiri, T., Prange, R. K., Thompson, A. K., Bancroft, R. D., Puttongsiri, T., Prange, R. K., Thompson, A. K., Bancroft, R. D. (2018). Controlled Atmosphere Storage of Fruit and Vegetables. United Kingdom: CABI.
3. Packaging and Storage of Fruits and Vegetables: Emerging Trends. (2021). (n.p.): Apple Academic Press.
4. Rao, C. G., Rao, C. G. (2015). Engineering for Storage of Fruits and Vegetables: Cold Storage, Controlled Atmosphere Storage, Modified Atmosphere Storage. India: Elsevier Science.

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	3	1	2	2	2	1	2	1	1	2	3	1
CO2	3	2	1	1	2	1	1	2	1	1	2	1	2	3	1
CO3	3	2	1	2	1	1	1	1	2	2	1	2	2	3	1
CO4	2	1	1	2	2	1	2	1	2	1	2	1	2	3	1
CO5	2	1	1	3	1	1	2	1	2	1	1	1	2	3	1
Avg	2.4	1.4	1	2.2	1.4	1.2	1.6	1.4	1.6	1.4	1.4	1.2	2	3	1

- 1-Low, 2- Medium, 3- high, '-no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The objective is to equip students with comprehensive knowledge of the bakery industry, focusing on innovation, health-oriented products, and efficient production practices.

UNIT I INTRODUCTION**9**

Historical development and contemporary status of the bakery industry in India. Overview of bakery products as per current regulations, including bread, biscuits, cakes, pastries, rusks, crackers, and buns. Discussion on specifications, current industry status, and future prospects, including the impact of sustainability and technological advancements.

UNIT II BAKERY INGREDIENTS**9**

Classification and roles of bakery ingredients. Essential ingredients: flour, yeast, sourdough, water, salt. Other ingredients: sugar, colorants, flavors, fats, milk, milk powder, bread improvers, leaveners, and yeast foods. Emphasis on modern alternatives such as plant based shortenings, clean label emulsifiers, and antioxidants.

UNIT III: TRADITIONAL AND SPECIALTY PRODUCTS**9**

Production, quality control, and innovations in traditional products: cakes, biscuits, pastries, and pretzels. Focus on enriched and dietetic bakery products using alternative flours (e.g., whole wheat, quinoa, almond). Exploration of functional and health oriented bakery products, including gluten free and low sugar options.

UNIT IV: INTERNATIONAL SPECIALTY PRODUCTS**9**

Exploration of bakery products from around the world with a focus on emerging trends. European specialties, Italian artisanal products, Mexican pan dulce, and Turkish delights. Discussion on global influences and fusion trends in bakery products.

UNIT V: BAKERY PLANT LAYOUT**9**

Design and maintenance of bakery and confectionery plants: principles of food plant design, site selection, and layout. Detailed exploration of classical and modern layouts, including lean manufacturing principles. Focus on process chart preparation, machinery layout, preventive and breakdown maintenance, and the impact of Industry 4.0 technologies on equipment maintenance.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, students will be able to:

CO 1: Learn about the basics of baking unit and its products

CO 2: Grasp the fundamentals of bakery ingredients and their roles in the baking process.

CO 3: Learn about the traditional and special type of products

CO 4: Identify and understand specialty bakery products and emerging trends in the industry.

CO 5: Design effective and modern bakery plant layouts, incorporating current best practices and technological advancements.

TEXTBOOKS:

1. Matz, Samuel A. *Bakery Technology and Engineering*. 1992, 3rd Edition, Chapman & Hall, London.
2. Cauvain, Stanley P., and Young, Linda S. *Technology of Bread Making*. 2007, Springer.

REFERENCES:

1. Edwards, W.P. *Science of Bakery Products*. RSC, UK, 2007.
2. Matz, Samuel A. *Equipment for Bakers*. Pan Tech International Publication, 1988.
3. Hui, Y.H. *Bakery Products: Science and Technology*. Blackwell, 2006.
4. Zhou, *Bakery Products: Science and Technology*. Second Edition, 2014.

COURSE ARTICLUATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	1	1	2	1	2	2	1	1	2	3	1	3	1	2
CO2	2	2	2	1	2	3	3	1	1	2	1	2	2	2	2
CO3	1	1	2	2	2	1	2	2	2	1	2	1	1	2	1
CO4	2	2	1	1	1	2	2	2	2	1	1	2	1	1	2
CO5	2	2	1	2	2	1	2	1	2	1	2	2	2	2	1
Avg	1.8	1.6	1.4	1.6	1.6	1.8	2.2	1.4	1.6	1.4	1.8	1.6	1.8	1.6	1.6

- 1-Low, 2- Medium, 3- high, '- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

The objective is to provide a comprehensive understanding of flour and dough properties essential for bakery production.

UNIT I FLOUR**9**

Flour: Refined, composition, nature of gluten and its functions in bread making and baking. Simple tests for flour quality, colour, gluten and water absorption. Blended flours and their suitability for use in different types of baked products. Flour improvers.

UNIT II WHEAT FLOUR**9**

Wheat grain structure and composition, classification and grading, dry milling of wheat, flour characteristics, optimization, chemistry & biochemistry – wheat proteins, adverse reactions to wheat proteins, polysaccharides, interaction within components and interaction with other components

UNIT III PHYSIOCHEMICAL TESTS & FUNCTIONAL TESTS**9**

Principles and methods of estimation of moisture, protein, ash, minerals, fats, diastatic activity, starch damage content, maltose value, flour colour grade value and flour particle size distribution. Principles and methods of estimation of gluten quantity, SDS -Sedimentation volume, falling number, dough raising capacity and alkaline water retention test. Significance of above tests in relation to bread, biscuits and cakes.

UNIT IV BASIC APPROACHES TO DOUGH RHEOLOGY**9**

Dough structure and basics of rheology. Creep and recovery, viscometry, stress relaxation, oscillatory measurements. Empirical and fundamental testing. Rheological behaviour of dough and gluten. Rheological properties of dough from high extraction, whole wheat and composite flours. Importance of dough and gluten viscoelasticity in gas retention and bread making. Bakery ingredients and dough rheology: Effects of water, yeast, oxidation and compounds with disulfide and thiol groups, sugar and emulsifiers on rheological properties of dough.

UNIT V RHEOLOGICAL TESTS**9**

Flour constituents, processing parameters and dough rheology: Influence of proteins, gluten, starch and enzymes on rheological properties of dough. Effects of mechanical work, mixing time and temperature on dough rheology. Application of dough recording mixers for assessing physical properties of the dough such as mixing behaviour, water absorption, dough strength and stability. Determination of Extensograph characteristics of the dough. Application of viscoamylograph in dough testing

TOTAL:45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course the students would have the knowledge to

CO1: Understand the use of wheat flour in bakery products

CO2: Perform the different tests for bakery products

CO3: Understands about the physiochemical and functional tests

CO4: Explain the concept of dough structure and basics of rheology

CO5: Assess the importance of rheological test for bakery products

REFERENCES:

1. Matz, Samuel A., —Bakery Technology and Engineering, 1992, 3rd Edition, Chapman & Hall, London.
2. Edwards W.P. — Science of bakery products, RSC, UK, 2007
3. Hui.Y.H. - Bakery products, Science and Technology, Blackwell, 2006
4. Zhou - Bakery products, Science and Technology, Second edition, 2014

COURSE ARTICLUATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	2	3	1	2	2	1	1	1	2	1	3	1	2	1
CO2	1	2	2	1	2	2	2	1	2	1	1	2	2	2	1
CO3	2	2	1	2	1	3	1	2	2	1	2	1	2	2	1
CO4	1	2	1	2	1	2	1	2	2	1	2	1	2	3	2
CO5	2	2	1	2	1	2	1	2	1	1	2	1	1	3	2
Avg	1.6	2	1.6	1.6	1.4	2.2	1.2	1.6	1.6	1.2	1.6	1.6	1.6	2.4	1.4

- 1-Low, 2- Medium, 3- high,'- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

This course covers the bread-making process, including formulation, mixing, fermentation, proofing, and baking. It explores various methods such as straight dough and sponge and dough, and their advantages and limitations. It also examines ingredients, bread-making machines, and cake baking techniques. The objective is to understand and optimize bakery processes for bread and cakes.

UNIT I BREAD MAKING PROCESS**9**

Bakery Industry Overview, Bread formulation and basic procedures: mixing, fermentation, proofing, baking, Raw material receiving, quality check, batch making, kneading, molding, panning, proofing, baking, cooling, slicing, packing. Processes Straight dough method, sponge and dough methods, soaker and dough, frozen dough, microwave process, Advantages and limitations of various bread processes.

UNIT II INGREDIENTS & BREAD MAKING MACHINES**9**

Ingredients and Additives, Role of ingredients, additives, and improvers in bread making. Chemical leavening agents: baking powder, sodium bicarbonate, ammonium bicarbonate, cream of tartar. Bread Types and Quality, Methods of bread preparation, quality aspects, and standards. Machines Dividers and rounder's: construction, principles, and operations.

UNIT III BAKING OF CAKES**9**

Ingredients and Mixing, Role of flours, oils, fats, eggs, sugar, dried fruits, and nuts. Types of cakes and mixing methods. Techniques and Equipment Heat transfer, batter mixing, delivery, and baking ovens (band, tunnel, reel).

UNIT IV MIXING METHODS AND PROCESSING TECHNOLOGY OF CAKES**9**

Cake Types and Methods, shortening style cakes, creaming method, flour batter method, emulsion, continuous batter mixing. Foam style cakes: angel food, sponge, chiffon, genoise. Cake Production Mixing, baking, cooling, packaging. Cake faults and remedies: shape, structure, texture, crust, color.

UNIT V CAKE MAKING MACHINES**9**

Encrusting Machines, Construction, feed system, moulding (extrusion nozzle, flourless, disk moulding), transmission, operation.

UNIT VI PASTRY**9**

Basic Formulation and Types, Flaky, puff, and Danish pastry. Methods for pie preparation, Danish pastries, and role of ingredients, Cold and hot pastries.

TOTAL: 45 HOURS**COURSE OUTCOMES(COs):**

CO 1: Understand the role of ingredients in cake baking processes.

CO 2: Understand different mixing methods and machinery.

CO 3: Understand pastry production.

CO 4: Learn about the process and ingredients of bread making

CO 5: explore about the machineries used in bread making

REFERENCES

1. Hui, Y. H. *Bakery Products: Science and Technology*, Blackwell, 2006.
2. Zhou, *Bakery Products: Science and Technology*, Second Edition, 2014.

COURSE ARTICLUATION MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	2	1	1	1	2	1	2	1	1	1	2	1	1	2
CO2	2	3	2	2	2	1	2	1	2	2	3	2	1	2	2
CO3	2	2	1	1	2	2	1	1	1	1	2	2	1	1	2
CO4	1	2	1	2	2	2	2	1	2	2	3	2	1	2	1
CO5	1	2	2	1	1	1	1	1	2	1	2	2	1	2	1
Avg	1.6	2.2	1.4	1.4	1.6	1.6	1.4	1.2	1.6	1.4	2.2	2	1	1.6	1.6

- 1-Low, 2- Medium, 3- high,'- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

This course covers biscuit and cookie production, including formulation, baking, and machinery. It also explores crackers and similar products. The goal is to optimize baking processes and equipment.

UNIT I CLASSIFICATION AND PROCESSING TECHNOLOGY OF BISCUITS 9

Biscuits Types - Hard and soft dough biscuits: ingredients, formulations, mixing, forming, baking, flavouring, cooling, packaging. Factors affecting biscuit dough spread during baking.

UNIT II BISCUIT MAKING MACHINES 9

Sheeting Machines, Sheeting process, parameters, sheeters, gauge rolls, laminators. Cutters, Reciprocating and rotary cutters: construction, shaping principles, and transmission.

UNIT III CLASSIFICATION AND PROCESSING TECHNOLOGY OF COOKIES 9

Ingredients and Quality, Features of cookie ingredients, quality assessment. Cookie Production, Types of cookies, general production process: mixing, dough sheeting, baking, cooling, packaging.

UNIT IV COOKIE MAKING MACHINES 9

Machines, Rotary moulders, extruders, and depositors: construction, principles, and operations.

UNIT V CRACKERS AND MISCELLANEOUS BISCUIT LIKE PRODUCTS 9

Crackers, Classification: cream, soda, and snack crackers. Manufacturing technology. Others, Wafers and pretzels.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

CO1: Understand the processing technology of biscuits.

CO2: Understand the workings of biscuit

CO3: Understand the processing technology of cookies.

CO4: Understand about cookie making machines.

CO5: Understands about the manufacturing of crackers, wafers and pretzels

REFERENCES

1. Edwards, W. P. *Science of Bakery Products*, RSC, UK, 2007.
2. Samuel A. Matz. *Equipment for Bakers*, Pan Tech International Publication, 1988.
3. Matz, Samuel A. *Bakery Technology and Engineering*, 3rd Edition, Chapman & Hall, London, 1992.

COURSE ARTICLUATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	2	1	3	1	2	3	2	2	1	1	1	2	1	1
CO2	2	1	1	2	2	2	2	2	1	3	2	1	1	2	2
CO3	1	2	2	2	2	2	1	1	3	2	1	1	1	2	1
CO4	2	2	1	1	1	2	1	2	1	1	1	2	1	2	1
CO5	1	2	1	2	1	2	2	1	1	2	1	2	1	2	2
Avg	1.6	1.8	1.2	2	1.4	2	1.8	1.6	1.6	1.8	1.2	1.4	1.2	1.8	1.4

- 1-Low, 2- Medium, 3- high, '- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

This course covers ingredient specifications, food safety, hygiene practices, and sensory assessment to ensure quality and compliance in bakery operations.

UNIT I SPECIFICATIONS FOR BAKERY INGREDIENTS AND PRODUCTS 9

BIS Standards, Whole wheat flour, protein rich flour, Maida, fortified Maida, suji, wheat flour for bread/biscuit, limits for contaminants and residues.

UNIT II FOOD SAFETY REGULATIONS & CERTIFICATION 9

Testing and Certification, need for food testing, NABL labs, GMP, GHP, GLP practices, HACCP, BIS, FSSAI regulations, packaging, labelling, registration, and licensing.

UNIT III BAKERY HYGIENE 9

Cleaning and Sanitation, General cleaning and sanitizing programs, methods, properties of food soils, cleaning agents, and sanitizers.

UNIT IV SAFETY AND SANITATION 9

Health and Safety, Safety rules, practices, sanitation, equipment duties, hygiene codes.

UNIT V SENSORY ATTRIBUTES OF BAKERY PRODUCTS 9

Sensory Assessment, Principles, attributes, senses, general requirements, factors affecting sensory attributes.

TOTAL: 45 HOURS

COURSE OUTCOMES (COs):

CO1: Understand different specifications for bakery products.

CO2: Understand food safety regulation and certifications

CO3: Learns about the bakery hygiene practices

CO4: Learns about the safety and sanitation rules

CO5: Understand sensory attributes of bakery products.

REFERENCES

1. Hui, Y. H. *Bakery Products: Science and Technology*, Blackwell, 2006.
2. Zhou, *Bakery Products: Science and Technology*, Second Edition, 2014.
3. Edwards, W. P. *Science of Bakery Products*, RSC, UK, 2007.

COURSE ARTICLUATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	1	1	2	1	1	3	2	1	2	2	2	2	1	1
CO2	2	2	2	1	2	2	1	3	2	2	2	1	1	2	2
CO3	2	2	1	1	2	1	2	2	2	1	3	1	2	1	2
CO4	1	2	2	2	3	1	2	1	2	2	2	1	2	1	2
CO5	1	2	1	1	1	1	2	2	1	3	1	1	2	2	2
Avg	1.6	1.8	1.4	1.4	1.8	1.2	2	2	1.6	2	2	1.2	1.8	1.4	1.8

- 1-Low, 2- Medium, 3- high,'- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

This course covers sugar confectionery, compressed tablets, hard candy, fondants, and creams, focusing on formulations, processing, quality parameters, and troubleshooting to ensure optimal product characteristics.

UNIT I CONFECTIONERY**9**

Definition and significance of sugar confectionery. Classification and technical considerations: total soluble solids (TSS), pH, acidity. Raw materials: types of sugar and alternative bulk sweeteners. Syrup production, enzyme applications, and additives. Quality parameters, common faults, and corrective measures. Spoilage and ingredient optimization for various confectionery types, including toffees and sugar boiled candies.

UNIT II COMPRESSED TABLETS AND LOZENGES**9**

Overview of formulations and ingredients: base materials, binders, lubricants, disintegrants, acids, flavours, colors, and active ingredients. Processing techniques for lozenges, wafers, and tablets. Characteristics, common issues, and troubleshooting.

UNIT III HARD CANDY**9**

Introduction to hard candy formulations and ingredients. Processing steps and technologies for hard candy production. Analysis of product characteristics, including chemical changes, microstructure, and stability/shelf life.

UNIT IV: FONDANTS AND CREAMS**9**

Overview of fondant and cream formulations and ingredients. Manufacturing processes for fondants, powdered fondants, and creams. Examination of product characteristics, potential problems, and troubleshooting strategies.

UNIT V CARMEL, FUDGE, AND TOFFEE**9**

Introduction to formulations and ingredients for caramel, fudge, and toffee: sweeteners, dairy ingredients, fats, emulsifiers, hydrocolloids, salts, flavors, and colors. Processing techniques: mixing, emulsification, cooking, browning, cooling, and forming. Product characteristics and troubleshooting.

TOTAL: 45 HOURS**COURSE OUTCOMES(COs):**

At the end of the course, students will be able to:

CO 1: Understand the fundamentals of various confectionery products and their production processes.

CO 2: Understands the compressed and lozenges formulations

CO 3: Understands the manufacturing of Hard candy

CO 4: Analyze the production methods for hard candy, fondants, and creams.

CO 5: Understands Formulate and troubleshoot recipes for caramel, fudge, and toffee.

REFERENCES:

1. Jackson, E.B. *Sugar Confectionery and Chocolate Manufacture*. Blackie Academic & Professional, 1992.
2. Hartel, W. *Confectionery Science and Technology*. Springer, 2018.

COURSE ARTICLUATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	1	2	1	1	2	1	2	1	2	1	1	2	1	1
CO2	1	1	2	1	2	2	2	2	1	1	2	2	1	2	1
CO3	2	1	2	2	2	1	1	1	2	1	2	2	2	2	2
CO4	1	2	2	1	2	2	2	2	1	2	2	2	1	2	2
CO5	2	1	2	1	2	1	2	1	2	2	1	1	2	2	2
Avg	1.6	1.2	2	1.2	1.8	1.6	1.6	1.6	1.4	1.6	1.6	1.6	1.6	1.8	1.6

- 1-Low, 2- Medium, 3- high, '- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

This course covers food packaging fundamentals, including materials, types, and design. It explores packaging for bread, biscuits, and confectionery, and advancements in packaging technologies like MAP, smart packaging, and material standards.

UNIT I INTRODUCTION**9**

Overview of food packaging: history, importance, and functions. Properties of packaging materials and package design. Testing of flexible packaging materials. Classification of packaging materials: rigid, semi rigid, flexible. Types of containers: primary, secondary, flexible, rigid, hermetic, and non-hermetic.

UNIT II BREAD PACKAGING**9**

Storage and packaging specifications for bread. Characteristics of packaging materials and their impact on bread quality. Types of packaging: fundamental classifications and material options.

UNIT III BISCUIT PACKAGING**9**

Types of biscuit packaging and their functions. Packaging materials and techniques: Modified Atmosphere Packaging (MAP), Vertical Form Fill Seal (VFFS), On Edge Flow pack, trays, pile packs, cartons, and tins.

UNIT IV PACKAGING OF CONFECTIONERY PRODUCTS**9**

Packaging materials for confectionery: metal cans, paper types, metal foils, transparent and metallized films, shrink and stretch films, laminates. Wrapping materials for display and advertising. Mechanical sealing methods and desiccant pouches.

UNIT V ADVANCES IN PACKAGING**9**

Recent advancements in packaging materials and methods. Overview of primary, secondary, and tertiary packaging technologies. Selection criteria for packaging materials and standards. Modern techniques for extending product shelf life: MAP, hermetic packaging, and intelligent/smart packaging technologies.

TOTAL: 45 HOURS**COURSE OUTCOMES(COs):**

At the end of the course, students will be able to:

CO 1: Grasp the basics of food packaging and its importance.

CO 2: Understand and apply various packaging methods for bread

CO 3: Understand the packaging methods and its functions for biscuits

CO 4: Understands about the confectionary packaging methods and materials

CO 5: Explore and utilize advanced packaging techniques and materials

TEXTBOOKS:

1. Davidson, I. *Biscuit, Cookie, and Cracker Production: Process, Production, and Packaging Equipment*. Academic Press, 2019.
2. *Confectionery Products Handbook (Chocolate, Toffees, Chewing Gum & Sugar Free Confectionery) *. Asia Pacific Business Press, 2013.

REFERENCES:

1. Matz, Samuel A. *Equipment for Bakers*. Pan Tech International Publication, 1988.
2. Cheng, Ling Min. *Food Machinery*. Ellis Horwood, 1992.
3. Matz, Samuel A. *Bakery Technology and Engineering*. 1992, 3rd Edition, Chapman & Hall, London.

COURSE ARTICLUATION MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	1	2	2	1	2	1	1	1	2	2	2	2	1	1
CO2	2	2	1	2	2	1	2	2	2	1	1	1	2	3	2
CO3	2	2	3	1	1	2	2	1	2	2	3	2	3	2	1
CO4	1	2	2	2	2	2	1	2	2	2	1	2	2	2	2
CO5	3	1	1	2	1	2	3	1	1	2	2	2	1	2	2
Avg	2.2	1.6	1.8	1.8	1.4	1.8	1.8	1.4	1.6	1.8	1.8	1.8	2	2	1.6

- 1-Low, 2- Medium, 3- high,'- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

Understand drying and storage methods for major, minor, and plantation spices, focusing on their impact on microbial contamination and active principles. Explore the forms and functions of spices, including their roles as preservatives and medicinal agents. Master extraction techniques for oleoresins and essential oils. Develop quality control skills for evaluating and maintaining spice quality.

UNIT I DRYING AND STORAGE OF MAJOR SPICES**9**

Different methods of drying and storage, microbial contamination of stored product, influence of temperature and time combination on active principles of spice crops, viz., Pepper, Cardamom, onion, ginger and turmeric, Extraction of oleoresin and essential oils.

UNIT II DRYING AND STORAGE OF MINOR SPICES**9**

Different methods of drying and storage, microbial contamination of stored product, influence of temperature and time combination on active principles of spice crops, viz., Cumin, Coriander, Cinnamon, fenugreek, pepper, Garlic, Clove and Vanilla. Extraction of oleoresin and essential oils.

UNIT III DRYING AND STORAGE OF PLANTATION CROPS**9**

Different methods of drying and storage, microbial contamination of stored product, influence of temperature and time combination on active principles of plantation crops, viz., coconut, arecanut, cashewnut, oil palm, palmyrah, cocoa, tea and coffee.

UNIT IV FORMS, FUNCTIONS, AND APPLICATION OF SPICES**9**

Spice forms and composition – fresh whole spices, dried spices. Spice extractives – essential oils, oleoresins, other spice extractives. Functions of spices – primary function of spices, secondary function – preservatives, antimicrobials, antioxidants. Emerging functions of spices – spices as medicines, traditional medicine, modern medicine.

UNIT V EQUIPMENT IN SPICE PROCESSING**9**

Spice cleaning - Magnets, sifters, air tables, destoners, sir separators, indent separators, spiral separators. Spice reconditioning. Spice grinding - Different mills sifting operations, ambient condition grinding, cryogenic grinding. Post processing treatments - Ethylene oxide, propylene oxide, irradiation, steam sterilization.

TOTAL: 45 HOURS**COURSE OUTCOMES (Cos):**

At the end of the course, the students will be able to

CO1 learn about drying and storage of spices

CO2 Acquire knowledge on forms, functions and application of spices

CO3 Learn about equipment in spice processing.

CO4 Learn about the functions and forms of spices and also its applications

CO5 Understand about the equipment used in spice processing

TEXTBOOKS:

1. Pandey, P. H. Post-Harvest Engineering of Horticultural Crops through objectives. Saroj Prakasam, Allahabad. 2002.
2. Shanmugavelu KG, Kumar N, Production Technology of Spices and Plantation Crops, 1st Edition, Peter

REFERENCES:

1. ASTA, Official analytical methods of the American Spice Trade Association, IV Edition, 1997.
2. Pruthi, J.S. Spices and Condiments Chemistry, Microbiology and Technology. 1stEdition. Academic Press Inc., New York, USA. 2011

COURSE ARTICLUATION MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	1	1	2	2	2	1	1	1	1	1	2	2	1	2
CO2	3	2	2	3	1	3	2	2	2	1	1	3	1	2	3
CO3	3	2	2	2	2	3	3	1	1	2	1	3	2	1	2
CO4	2	2	1	3	1	2	2	2	2	1	1	2	2	2	2
CO5	2	1	1	1	2	1	2	1	2	1	3	1	2	1	2
Avg	2.4	1.6	1.4	2.2	1.6	2.2	2	1.4	1.6	1.2	1.4	2.2	1.8	1.4	2.2

- 1-Low, 2- Medium, 3- high,'- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

Learn the green coffee processing stages, including drying, curing, and grading, understand decaffeination methods, coffee roasting, and grinding techniques, explore extraction methods for soluble solids and volatile compounds, and drying techniques like spray and freeze drying.

UNIT I GREEN COFFEE PROCESSING 9

Introduction, Occurrence—chemical constituents—harvesting, dry processing method – natural and artificial drying, wet processing method – receiving, pulping, separation, fermentation, washing, draining, drying of the parchment coffee. Curing – redrying, cleaning, hulling, size grading, sorting. Storage, handling. Grading storage, pre-treatments and blending.

UNIT II DECAFFEINATION OF COFFEE 9

Introduction, solvent decaffeination, water decaffeination, supercritical carbon dioxide decaffeination, decaffeination of roasted coffee and extract, caffeine refining.

UNIT III ROASTING AND GRINDING 9

Introduction, process factors in roasting – mechanisms, chemical changes, heat factors, physical changes, measurement of roast degree. Roasting equipment – horizontal drum roasters, vertical fixed drum, rotating bowl, fluidized beds and ancillaries. Grinding equipment.

UNIT IV EXTRACTION 9

Introduction, mechanism and methods – soluble solids extraction, volatile compound extraction, compositional factors. Process equipment – percolation batteries, screw extractor.

UNIT V DRYING 9

DRYING - Introduction, process factors in spray drying – methods, compositional changes, spray formation, spray air contact, mechanisms of water removal & volatile compound retention, agglomeration. Process factors in freeze drying – methods, mechanisms of water removal & volatile compound retention. Pre-concentration – evaporation, freeze concentration, reverse osmosis. Process equipment.

TOTAL: 45 HOURS**COURSE OUTCOMES (Cos):**

At the end of the course, the students will be able to

CO 1 Learn about processing steps involved in green coffee processing and decaffeination.

CO 2 Acquire knowledge on post-harvest processing of coffee

CO 3 Learn about processing involved in instant coffee

CO 4 Understand about the various methods and mechanism of extraction

CO 5 Understand about the drying methods and process

TEXT BOOKS

1. Clarke.R.J & Macrae.R – Coffee, Volume 2: Technology 1st edition.

REFERENCES

1. Shanmugavelu KG , Kumar N, Production Technology of Spices and Plantation Crops, 1st Edition, Peter KV Publisher : Agrobios (India), 2018.

2. Pruthi, J.S. Spices and Condiments Chemistry, Microbiology and Technology. 1stEdition. Academic Press

COURSE ARTICLUATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	2	1	1	2	1	2	1	1	2	3	1	2	2	2
CO2	2	3	2	2	1	2	3	2	1	1	1	1	3	2	1
CO3	3	2	2	2	2	1	3	1	2	2	2	1	2	3	2
CO4	4	3	2	2	1	2	2	2	1	2	1	1	2	2	1
CO5	1	2	1	1	2	2	2	1	2	1	2	1	2	2	2
Avg	2.2	2.4	1.6	1.6	1.6	1.6	2.4	1.4	1.4	1.6	1.8	1	2.2	2.2	1.6

- 1-Low, 2- Medium, 3- high,' - 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

Understand tea types, harvesting, and plucking methods, including green, oolong, CTC, and specialty teas. Learn green tea production processes and biochemical changes. Explore the semi-fermented tea process and its characteristics. Study black tea processing stages and its chemistry. Understand instant tea production and quality control.

UNIT I INTRODUCTION**9**

Tea - Occurrence–chemistry of constituents–harvesting - tea plucking – basics of plucking, tipping, systems of plucking, standards of plucking, plucking interval, different types of plucking. Tea plucking machines –types of tea–green, oolong and ctc. Speciality teas, herbal teas, china tea, flavoured teas, teas with historical associations, packaging format, organically grown tea.

UNIT II GREEN TEA**9**

Introduction to green tea production, manufacturing process – Post harvest spreading of leaves – Fixing, Rolling, Shaping and Drying. Chemical and Biochemical changes during green tea processing. Character of green tea – taste – chemical components responsible for tea taste, roast aroma.

UNIT III SEMI-FERMENTED TEA**9**

Manufacturing process for semi fermented tea – Plucking, Pruning, Jat, Flush, Withering, Rolling, Shifter, Fermentation, Drying, Sorting and Grading. Character of semi fermented tea, - aroma of oolong tea, mechanism, aroma pattern under different degrees of fermentation, infusion colour and taste of oolong tea.

UNIT IV BLACK TEA**9**

Introduction, orthodox tea, CTC tea. principal stages of processing – withering, cutting, rolling, oxidation or fermentation – different methods, drying or firing, sorting and fibre removal. Different grades of tea. Chemistry and biochemistry of black tea production - non volatiles. Green leaf polyphenols, polyphenol oxidase, black tea polyphenols. Tea aroma - Introduction, biogenetic pathways of the aroma compounds in the tea, changes in the composition of the aroma complex, use of the aroma complex.

UNIT V INSTANT TEA**9**

Introduction, production of instant tea – Extraction, Decanting, aroma stripping, De-creaming, Concentration, Blending, Drying. Grading of tea, Processing and quality control.

TOTAL: 45 HOURS**COURSE OUTCOMES (Cos):**

At the end of the course, the students will be able to

CO 1 Learn about processing steps involved in different types of tea

CO 2 Acquire knowledge on post-harvest processing of tea

CO 3 Learn about processing involved in instant tea.

CO 4 Learn the appropriate drying and storage techniques for minor spices to maintain their active principles and prevent microbial contamination.

CO 5 Acquire insights into the different equipment used in spice processing, including cleaning, grinding, and post-processing treatment

TEXTBOOKS:

1. Wilson.K.C – Tea-cultivation to consumption, Springer, 2012

REFERENCES:

1. Shanmugavelu KG , Kumar N, Production Technology of Spices and Plantation Crops, 1st Edition, Peter KV Publisher : Agrobios (India), 2018.
2. Pruthi, J.S. Spices and Condiments Chemistry, Microbiology and Technology. 1stEdition. Academic Press Inc., New York, USA. 2011.

COURSE ARTICLUATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	1	2	1	2	1	1	1	2	1	2	2	1	1	1
CO2	1	3	1	1	1	2	2	2	1	1	2	2	2	2	1
CO3	2	1	1	1	2	2	3	1	2	2	2	3	1	2	3
CO4	1	2	2	2	3	1	2	2	2	1	2	1	2	2	2
CO5	1	2	2	2	1	2	1	1	2	3	2	3	2	1	2
Avg	1.4	1.8	1.6	1.4	1.8	1.6	1.8	1.4	1.8	1.6	2	2.2	1.6	1.6	1.8

- 1-Low, 2- Medium, 3- high, '- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

Understand cocoa development, flavour formation, and post-harvest treatments. Learn cocoa processing methods, including bean selection and powder production. Explore chocolate manufacturing processes and quality assessment. Identify chocolate defects and quality evaluation techniques. Study how processing affects flavour in milk and dark chocolates.

UNIT I COCOA**9**

Introduction, Flowering and pod development, Harvesting and pod opening, Bean composition and flavour precursor formation, Flavour development during post-harvest treatments of cocoa – Fermentation process and drying.

UNIT II INDUSTRIAL COCOA PROCESSING**9**

Introduction, cocoa processing and technology – bean selection and quality criteria, cleaning, breaking and winnowing, sterilization, alkalization, roasting, nib grinding and liquor treatment, liquor pressing, cake grinding, cocoa powder production.

UNIT III CHOCOLATE MANUFACTURING PROCESSES**9**

Mixing, refining, conching – dry conching, pastry phase, liquid conching, tempering, lipid crystallization and continuous phase character during chocolate, particle distribution in chocolate.

UNIT IV CHOCOLATE QUALITY AND DEFECTS**9**

Chocolate quality – rheological measurements of chocolate quality, sensory evaluation of chocolate quality. Chocolate defects – fat bloom, sugar bloom.

UNIT V CHEMISTRY OF FLAVOR DEVELOPMENT DURING PROCESSING**9**

Introduction, influence bean selection on chocolate flavour quality, effect of roasting, flavour development during chocolate manufacture, key flavour compounds in milk chocolate, key flavour compounds in dark chocolate. Sensory perception of quality in chocolates.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course, the students will be able to

CO 1 Understand the cocoa plantation

CO 2 Acquire knowledge on cocoa processing and chocolate manufacturing technology

CO 3 Learn about the manufacturing process of the chocolate

CO 4 Understand about the quality and defects of chocolate

CO 5 Learn about chemistry of flavour development during processing

TEXTBOOKS:

1. Emmanuel., - Chocolate science and technology, Wiley, 2010

REFERENCES:

1. Shanmugavelu KG , Kumar N, Production Technology of Spices and Plantation Crops, 1st Edition, Peter KV Publisher : Agrobios (India), 2018

COURSE ARTICLUATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	1	2	2	1	2	1	2	2	2	1	1	2	1	1
CO2	2	2	2	2	1	1	2	2	3	1	2	2	1	2	2
CO3	1	2	3	2	1	2	1	2	2	3	1	2	3	1	1
CO4	1	1	2	1	2	2	1	2	1	2	2	2	1	2	2
CO5	2	2	1	2	2	2	1	2	2	2	1	2	2	2	2
Avg	1.4	1.6	2	1.8	1.4	1.8	1.2	2	2	2	1.4	1.8	1.8	1.6	1.6

- 1-Low, 2- Medium, 3- high,'- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

Understand spice labeling, regulations, and quality maintenance. Learn spice packaging, grading, and analysis methods. Analyze tea and coffee for various quality parameters. Perform chemical analyses on spices. Conduct specific tests for contaminants and quality markers in spices.

UNIT I SPICE LABELING, STANDARDS, REGULATION AND QUALITY SPECIFICATION 9

Spice definition and labeling, spice regulations, spice authenticity and quality concerns, spice quality specifications, maintaining spice quality.

UNIT II PACKAGING, GRADING AND QUALITY ANALYSIS OF SPICES 9

Cleaning and grading of spices - packaging and storage of spices – grading specifications – AGMARK, ASTA, ESA specifications - processes involved in the manufacture of oleoresins and essential oils – quality analysis of spices and their derivatives

UNIT III ANALYSIS OF PLANTATION PRODUCTS 9

Tea & Coffee- Preparation of sample, Moisture content, Total ash, Water soluble ash, Determination of Caffeine content by different methods, Microscopic examination, Determination of solubility in boiling water, Determination of Iron filings and size of the particles, Test for presence of added colouring matter

UNIT IV ANALYSIS OF SPICES 9

Spices- Sample preparation, Determination of moisture, Acid insoluble ash, Determination of Cold Water Extract, Determination of Alcohol Soluble Extract , Calcium Oxide, Non Volatile Ether Extract, Volatile Oil, Crude Fibre

UNIT V SPICE SPECIFIC TESTS 9

Allyl isothiocyanate in Mustard, p-hydroxybenzyl isothiocyanate in white mustard, Microscopic Examination of Spices, Black Pepper- Determination of Bulk density, Light berries, Piperine content, Turmeric- Determination of curcumin content, Starch content, Detection of chromate content, Detection of Argemone seeds in Mustard, Detection of Mineral Oil in Black Pepper, Detection of Papaya seeds in Black, Pepper, Detection of Turmeric in Chillies and Coriander, Detection of Oil Soluble Colour, Determination of Light and Heavy Filth in Spices and Condiments, Determination of capsaicin content in chilli powder.

TOTAL: 45 HOURS**COURSE OUTCOMES(COs):**

At the end of the course the students will be able to

- CO 1** Understand the regulatory requirements, labeling, and quality standards for spices to ensure authenticity and maintain quality.
- CO 2** Gain knowledge of the processes involved in cleaning, grading, packaging, and storing spices, as well as the quality analysis of oleoresins and essential oils.
- CO 3** Learn the methods for preparing samples and analyzing the quality of tea and coffee, including moisture content, ash content, caffeine determination, and detection of contaminants.
- CO 4** Acquire skills in sample preparation and the determination of various quality parameters in spices, such as moisture, ash, volatile oil, and crude fiber
- CO 5** Develop expertise in conducting specific tests for individual spices, including determining the content of

active compounds and detecting adulterants and contaminants.

TEXTBOOKS:

1. Susheela R., Handbook of Spices, Seasonings, and Flavorings, CRC Press, 2006

REFERENCES:

1. ASTA, Official analytical methods of the American Spice Trade Association, IV Edition, 1997.
2. Pruthi, J.S. Spices and Condiments Chemistry, Microbiology and Technology. 1stEdition. Academic Press Inc., New York, USA. 2011.

COURSE ARTICLUATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	2	1	2	1	2	1	2	1	1	1	2	1	1	2
CO2	1	3	2	2	2	1	1	1	2	3	2	3	2	2	1
CO3	2	1	1	1	3	2	1	2	2	1	1	2	3	2	2
CO4	1	2	2	2	2	3	2	2	2	2	1	1	1	2	1
CO5	1	2	1	1	1	2	1	1	3	2	3	2	2	1	1
Avg	1.4	2	1.4	1.6	1.8	2	1.2	1.6	2	1.8	1.6	2	1.8	1.6	1.4

- 1-Low, 2- Medium, 3- high,'- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

Learn to create value-added spice products, extract and analyze spice oils and oleoresins, and prepare seasoning blends. Explore spice applications in culinary practices and value addition techniques for Indian spices.

UNIT I VALUE-ADDED PRODUCTS FROM SPICES 9

Value added products: Spice powders, Curry powders, Sterilized spices, Enriched Spices, Encapsulation, aqueous flavourants.

UNIT II EXTRACTION AND ANALYSIS OF SPICE OILS AND OLEORESINS 9

Spice Oils & Oleoresins: Flavor extraction from spices by different methods. Estimation of principle constituents in spices & spice products, residual solvent in spice oleoresins.

UNIT III PREPARATION OF SIMPLE SEASONING BLENDS 9

Simple seasoning blends - Soluble seasonings, celery salt, garlic salt and onion salt, chili powder, curry powder, pickling spice, poultry seasoning, pumpkin pie spice, apple pie spice, oriental five spice blend.

UNIT IV APPLICATIONS OF SPICES IN CULINARY PRACTICES 9

Spice applications - Marinades, rubs, glazes. Spice blends, seasonings and condiments.

UNIT V VALUE ADDITION TECHNIQUES FOR INDIAN SPICES 9

Value addition Indian spices - Whole spices, spice blends, crushed spices, curry mixes, curry pastes, pickled spices, freeze dried spices, dehydrated spices, natural food colors, spice oils and oleoresins.

TOTAL: 45 HOURS**COURSE OUTCOMES(COs):**

At the end of the course the students will be able to

CO 1 Understand the production and benefits of value-added spice products

CO 2 Learn various methods of flavor extraction from spices and the estimation of principal constituents in spices and spice products, including residual solvent analysis in spice oleoresins.

CO 3 Gain knowledge of the preparation and application of simple seasoning blends

CO 4 Acquire skills in using spices for marinades, rubs, glazes, and the creation of spice blends, seasonings, and condiments.

CO 5 Understand the methods of value addition for Indian spices,

TEXTBOOK:

1.Susheela R., Handbook of Spices, Seasonings, and Flavorings, CRC Press, 2006

2. Amir Baran .S.,Indian Spices – The legacy , production and processing of India’s treasured export, Springer, 2018.

COURSE ARTICLUATION MATRIX

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	1	1	1	2	2	2	1	1	2	1	1	2	1	1
CO2	2	2	1	2	3	2	2	2	1	1	1	2	1	1	2
CO3	1	3	1	2	1	1	2	1	1	3	2	3	2	2	2
CO4	1	2	2	2	2	1	2	1	1	1	1	2	1	2	2
CO5	1	2	1	1	2	2	2	1	1	1	3	1	2	2	2
Avg	1.2	2	1.2	1.6	2	1.6	2	1.2	1	1.6	1.6	1.8	1.6	1.6	1.8

- 1-Low, 2- Medium, 3- high,'- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

OBJECTIVES

Understand food packaging fundamentals, spice packaging requirements, and deterioration issues. Learn packaging methods for spices, including bulk and unit packages, and explore packing processes for coffee and tea.

UNIT I INTRODUCTION**9**

Introduction, History, Importance and functions of Food packaging. Properties of packaging material in relation to these functions, package design. Tests for flexible packaging materials. Materials used in packaging- rigid, semi rigid and flexible. Types of containers-primary & secondary, flexible & rigid, hermetic & non hermetic.

UNIT II PACKAGING OF SPICES**9**

Classification of spices with reference to packaging, determination of packaging requirement of spices, selection of packaging materials, objective assessment of packaging materials, Types of packaging materials – Paper and cardboard boxes, Aluminium foil, Combination of films, Co-extruded multi-layer films, tin and wooden containers.

UNIT III Deteriorative Characteristics and Packaging Requirements for Spices**9**

Nature and deteriorative characteristics of spices and spice products – Loss of aroma and flavour, Bleaching of colour, Loss of free flowing nature, microbial spoilage and insect infestation. Packaging material requirement of spices and spice products. Packaging for seeds and fruits, packaging for leaves and stems, packaging for flowers and buds, packaging for roots and rhizomes, Packaging for bark, wood and resins. Storage.

UNIT IV PACKAGING METHODS AND MATERIALS FOR SPICES**9**

Packaging methods & Materials for spices and spice products: Bulk packaging – whole spice, spice powders. Unit packages – whole spices, spice powders. Packaging of dry spice mixes and pastes. Packaging of sauces/liquid salad dressings and fat spreads. Packaging of oleoresins and volatile oils. Insect infestation and microbial contamination in spices. Quality control of spices.

UNIT V PACKING OF ROAST, INSTANT COFFEE AND TEA**9**

Introduction, packing of roast whole bean coffee, packing of roast and ground coffee, packing equipment – degassing plant, roast and ground coffee, Instant coffee, methods, process and equipment involved– Chicory chemistry - Quality grading of coffee weight control. Packing of Tea.

TOTAL: 45 HOURS**COURSE OUTCOMES (COs):**

At the end of the course the students will be able to

CO 1 Understand the basics of Food packaging

CO 2 Acquire knowledge on spice packaging on different aspects

CO 3 Learn about the packaging of coffee and tea.

CO 4 Learn about the packaging methods and materials used for spices

CO 5 Understand about the packaging procedure of coffee and tea

TEXTBOOK:

1. Peter K V, Handbook of herbs and spices, 2nd edition, Woodhead publishing company, 2006

REFERENCES:

1. Clarke.R.J & Macrae.R – Coffee, Volume 2: Technology 1st edition.
2. Shanmugavelu KG , Kumar N, Production Technology of Spices and Plantation Crops, 1st Edition, Peter KV Publisher : Agrobios (India), 2018

COURSE ARTICLUATION MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	2	1	2	1	2	2	1	1	2	2	1	2	1	1
CO2	2	1	1	1	2	2	1	3	2	1	1	2	1	2	2
CO3	1	2	2	2	2	2	1	2	3	1	2	1	3	1	3
CO4	1	2	2	3	1	2	2	2	2	2	1	2	1	2	2
CO5	1	2	2	2	2	3	3	1	2	2	1	2	2	2	1
Avg	1.4	1.8	1.6	2	1.6	2.2	1.8	1.8	2	1.6	1.4	1.6	1.8	1.6	1.8

- 1-Low, 2- Medium, 3- high,'- 'no correlation. Note: The average value of this course to be used for the program articulation matrix.

FT23043 INTRODUCTION TO FOOD SAFETY ANALYSIS AND QUALITY RISK MANAGEMENT L T P C
3 0 0 3

UNIT I INTRODUCTION 9

General overview of Food Safety, Food Industry: A glance, Understanding contemporary U.S. food safety policy, Food laws and policies of India, Study on Food-borne Hazards, Illness & Epidemics, Food GMP and its regulations.

UNIT II FOOD SAFETY 9

Food Safety Management System (HACCP LEVEL 4, ISO 22000/FSSC 22000), International standards and regulations for food safety, Understanding the basic concepts of microbiology in food safety, Emerging trends in food safety (like HARPC, etc), Food Quality Regulations and guidelines in India.

UNIT III QUALITY REGULATIONS 9

Quality, Quality Assurance and Quality Control in pharmaceutical industry, Qualification and Validation, Quality Assurance and Quality Control- Possible Problems and Fixes, Introduction to Quality Risk Management & Total Quality Management, Computer System Validation (CSV), WHO Risk Based Approach Analysis, Case Studies.

UNIT IV RISK CONTROL 9

Over view of food supply chain, Risks and Controls in Food Chain, Potential Hazards, Good Hygiene practices in food chain, Examples of Food safety Incidents, One Point Lessons in online Production, Risk and Control, Backward and forward flow of process line, Instrumental analysis of Food.

UNIT V SAFETY AND QUALITY ANALYSIS 9

Sensory Evaluation of Food, Good Laboratory Practices - Food Laws, Applied Statistical Method in Quality Assurance, Practical on Food Analysis – Hand on training on Physical Analysis, Chemical Analysis and Instrumentation Analysis of Food, Laboratory demonstration, Practicals and instrument Handling.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs):

- CO1 To make the student to understand about food hazards.
- CO2 To make the student to understand about the safety concerns in industry.
- CO3 To facilitate them in understanding the overall food quality controls.
- CO4 To perform risk assessment.
- CO5 To assess various safety and quality analysis.

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick
3. Food Safety Sanitation and Personal Hygiene
4. Food Safety Implementation from farm to fork – Puja Dudeja, Amarjeeth Singh, Sukhpal Khaur.

UNIT I INTRODUCTION 9

Food Safety: HACCP Principles, Haccp Plan, 2 Role of Pre requisite programmes (PRP) Operational Pre-REQUISITE Programmes (OPRP) and GMP in Food Industry, Implementation of HACCP in a food industry/retail food establishment/catering industry. Documentation required for implementation of HACCP.

UNIT II GLOBAL PERSPECTIVE 9

HACCP levels, CP's, CCP Controls, Audit: First, second- & third-party audits, CAPA report Comprehensive global perspective of HACCP (USA, Canada, UK, EU, Africa, Japan) HACCP as a part of ISO 22000/FSSC 22000 8, HACcP plan Preparation for different food products, Case Studies

UNIT III HACCP IN FOOD CHAIN 9

Introduction to Food Processing, Food processing and its types, Microbial, Chemical, Physical Hazards, HACCP generic Model, Importance of Equipment/ Process Selection, Advantages in Implementing HACCP, Risks at different stages of Food Chain. Food Preservation and techniques, Food Good Manufacturing Practices, Good Laboratory Practices HACCP Implementation in Storage and Transport, Retail and Distribution

UNIT IV CASE STUDIES 9

Food Plant Design, layout and Food Logistics, Food Packaging Technology and Labelling Food Microbiology, food-borne illness and hazards, Food Sensory Evaluation, Entrepreneurship Development in Food Processing, Case studies, Quality Risk Assessment, Quality Risk Management: Ins and Outs, Deviation Management, CAPA, and Change control, Case Study.

UNIT V PRE-REQUISITE PROGRAMMES 9

HACCP-based approach towards Food Safety, Principles of HACCP, Steps in HACCP, VACCP, Principles of Food Preservation, Processing and Packaging, Food Processing Operations, Principles, Good Manufacturing Practices, principles including novel and emerging methods, Hazards Associated with Sea foods, production of safe sea foods – Pre requisite programmes and HACCP, Risk assessment at different stages of sea food process, Application of HACCP, VACCP and TACCP system in Sea food Process

TOTAL: 45 PERIODS**COURSE OUTCOME**

- CO1 To make the student to understand about the HACCP and its principles
- CO2 To make the student to understand about the implementation of HACCP in food industries
- CO3 To facilitate them in understanding the overall protection and handling of food materials
- CO4 To facilitate them in understanding the case studies
- CO5 To make the student to understand the pre-requisite programmes

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick
3. HACCP a Systematic Approach to Food Safety, A comprehensive Manual for Developing and Implementing a Hazard Analysis and Critical Control Points plan by Grocery manufactures Association.

UNIT I INTRODUCTION 9

Introduction to GMP & PRP in the food industry, Global Food regulatory Authorities, Concept of HACCP implementation, Hazards and Risks, ISO 22000: Food Safety Management System.

UNIT II FOOD SAFETY MANAGEMENT SYSTEM 9

Role of Management in FSMS in a Food Industry, FSMS Auditing, types of Audits and CAPA reports: Food Safety System Certification 22000 (FSSC 22000): Introduction & Audit Requirements, Pest Management, pests of Food Processing and Production, Facilities and Risks Involved, Pest Detection Strategies, Pest Control Strategies, Export and Import Clearance, Commodity Clearance at IEC and regulations, Case Studies.

UNIT III APPLICATIONS OF HACCP 9

Historical Background, The Need for HACCP, Principles of HACCP System, Application of HACCP, HACCP in Small-large Food Business, Assessment of HACCP, Operational Maintenance, Introductory of HACCP Concept in Product Development, HACCP team and Resource Management, Novelities in HACCP for Food Operations, Principals Systems and schemes, Principles and associated Systems, Integrated Schemes and their limitations, CIP Background, COP Cleaning, Sanitization Chemistry, Common Cleaning Problems in Food Process environment.

UNIT IV PRODUCT ASSESSMENT 9

Formulation and Optimization of New Product, Sensory & Physical Estimation of Permuted Product, Analytical assessment of New Product Development Prototype, assessment with benchmark, Financial Estimation of Novel Products, Food safety Vigilance, Food Safety Problems with Acidic Foods, Contaminants, Adulterants, Legal compliance, regulatory affairs & Documentation, Hazards associated with drinking water, Risk Assessment and Risk Management, HACCP Case Studies – Industry Based Case Study

UNIT V FOOD SUPPLY CHAIN 9

Food Industry- An Overview, Role of GMP & GAP in Food Supply Chain, Principles of Food Supply Chain Management, Principles of Management, Food Quality & Safety Aspects of Food Supply Chain (An international perspective) Food Supply Chain Risk Management and Mitigation Strategies, Industry based Case Studies

TOTAL: 45 PERIODS**COURSE OUTCOME**

CO1 To make the student to understand about the overall food plant management

CO2 To make the student to understand about the regulations and their role in managing the food safety.

CO3 To facilitate them in understanding the overall management of food safety at all stages of food supply chain.

CO4 TO facilitate them in understanding the product assessment processes

CO5 TO make the student understand the food supply chain

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick
3. Food Safety Sanitation and Personal Hygiene
4. Food Safety Implementation from farm to fork – Puja Dudeja, Amarjeeth Singh, Sukhpal Khaur.

UNIT I OVERVIEW**9**

Food Safety and Standards Act of India, 2006: Provision, definitions and different sections of the Act and implementation, FSS Rules and Regulations, Overview of other relevant national bodies (e.g. APEDA, BIS, EIC, MPEDA, Spice Board etc.), International Food Control Systems/Laws, Regulations and Standards/Guidelines with regard to Food Safety – (i) Overview of CODEX Alimentarius Commission (History, Members, Standard setting and Advisory mechanisms: JECFA, JEMRA JMPR): WTO agreements (SPS/TBT), Important national and international accreditation bodies

UNIT II GLOBAL REGULATORY AUTHORITIES**9**

Food Regulatory Affairs: Introduction to global regulatory authorities for food Industry, Food GMP and its regulations, From Farm to Fork: Understanding the Food Regulatory Cycle [International perspective of USA, Europe, UK, Canada, GCC (UAE), South Africa, Australia & New Zealand], Food safety in the process chain,

UNIT III REGULATORY GUIDELINES**9**

Documentation for launch of a new food product and regulatory filing in US, Europe, UK, India, Canada and Japan, Food Industry IPR, Patents, Copyrights and Trademarks, Food Product Marketing, Import and Export regulations, Compliance guidelines, Govt. Audits (FSSAI, BIS, etc), Food Regulations & Guidelines in India, Food Licensing & Registration in India, Industry based case studies

UNIT IV EVOLUTION OF FSSAI**9**

FSSAI – Role, Functions, Initiatives (A General Understanding) Genesis and Evolution of FSSAI, Structure and Functions of Food Authority, Overview of systems and processes in Standards, Enforcement, Laboratory ecosystem, Imports, Third Party Audit etc., Promoting safe and wholesome Food (Eat Right India, Food Fortification, snf, Clean Street Food Hub, RUCO and various other social and behavioural change initiatives),

UNIT V FOOD BUSINESS OPERATORS**9**

Training and capacity building, Role of State Food Authorities. Food Safety Compliance System (FoSCoS), Food Safety Training and Certification (FoSTaC), Food Licensing and Registration System' or (FLRS), food business operators, Food Import Clearance System, Indian Food Laboratory Network, (INFoLNET) RUCO, Detect Adulteration with Rapid Test (DART) FSSAI e-Books on Food Safety (pink, purple, Yellow, Orange etc)

TOTAL: 45 PERIODS**COURSE OUTCOME**

CO1 To make the student to understand about the Food Safety

CO2 To make the student to understand about the regulations and training of food safety

CO3 To facilitate them in understanding the overall view of FSSAI laws and regulations.

CO4 To make the student understand the unification of various food laws under FSSAI

CO5 To facilitate the students to understand the processes to be followed by a food business operator

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book – Ronald H. Schmidt, Gary E. Rodrick
3. Food Safety and Hygiene Regulations.
4. www.fssai.gov.in

UNIT I INTRODUCTION 9

Good Laboratory Practices GLP: FPO, Prevention of Food adulteration Act, Food Safety and Standard Act, Testing Food for its Safety, AGMARK). Hygiene and Sanitation (HACCP, Good Manufacturing Practices, Introduction, fundamentals and principles of GLP, Documentation, records and preparation of SOPs, GLP compliance & preparation for certification; ISO / IEC 17025: 2017 & Laboratory accreditation Module 4: Internal Quality Audits for various Quality Management Systems (QMS)

UNIT II FOOD SAFETY IN LABORATORIES 9

Use of Computers in the laboratory , General Good Testing Conduct, International GLP of the OECD, FDA etc, Management, Personnel, Buildings & Equipment , Validation and Quality Assurance , Inspection of a testing facility , Laboratory demonstration, practicals and instrument handling, Case studies

UNIT III FOOD SAFETY IN HOSPITALITY INDUSTRY 9

Hospitality Industry – An overview (hotels, restaurants, cafeterias, hospitals, travel & tourism, contract caterings etc) Food safety sensitization in Hospitality Industry, Food safety in preparation and service Premises, safety and personnel health & hygiene, Supply and storage of food in Hospitality Industry

UNIT IV FOOD QUALITY MANAGEMENT 9

Basics of food microbiology and food borne-pathogens, Pest control management in Hospitality Industry, Food safety standards for Hospitality Industry (HACCP LEVEL 4, ISO 22000:2005, ISO 9001, ISO14000 etc), Food safety compliances in Hospitality Industry, International food safety legislations for Hospitality Industry (USA, UK, Europe, Australia, India, UAE etc perspectives) Food Quality Regulations and guidelines in India, Hospitality Industry based case studies.

UNIT V MICROBIAL SAFETY 9

Introduction to Food and Nutrition, Basics of Food Microbiology, Extrinsic and Intrinsic factors of microbial growth, Significance and principles of food preservation, Fermentation process and their products, Food Spoilage, Food safety guidelines for microbiology, Laboratory demonstration, practical and instrument handling, Industry based Case Studies

TOTAL: 45 PERIODS

COURSE OUTCOME

- CO1 To make the student understand good laboratory practices
- CO2 To make the student to understand about the Food Safety in laboratories
- CO3 To make the student to understand about the food safety in hospitality industry
- CO4 To facilitate them in understanding the overall management of food quality control.
- CO5 To facilitate the students in understanding the microbial safety guidelines

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick
3. Preventing food Poisoning in hospital and in home.

UNIT I INTRODUCTION**9**

Fundamentals of field level and laboratory sampling with reference to importance of statistical tools, Overview of basic/classical methods of food analysis, Overview of modern analytical techniques including mass spectrometry and molecular techniques, Principles of Quality assurance and Quality control with reference to food analysis and testing.

UNIT II ANTI-NUTRITIONAL FACTORS**9**

Principles and Basics of Food Chemistry and their role in Human Nutrition, Structure and functions of macro- and micro nutrients, Role of macro and micronutrients in human nutrition, Overview of food additives with respect to their technological functions, Overview of anti-nutritional factors and their removal from foods, Overview of enzymes as food processing aids, Overview of nutraceuticals and functions foods, Overview of food contaminants and adulterants and their effects on human health, Food allergens and allergen city, Importance of diet in alleviating health risks, especially non-communicable diseases.

UNIT III MICROBIAL QUALITY OF FOODS**9**

Food Microbiology & General principles of Food Hygiene, General principles of food microbiology and overview of food borne pathogens, Overview of sources of microorganisms in food chain (raw materials, water, air, equipment etc.) and microbiological quality of foods, Microbial food spoilage and Food borne diseases,

UNIT IV SANITATION**9**

General principles and techniques in microbiological examination of foods, Overview of beneficial microorganisms and their role in food processing and human nutrition, General principles of food safety management systems including traceability and recall – sanitation, HACCP, Good production and processing practices (GMP, GAP, GHP, GLP, BAP, etc)

UNIT V ANALYSIS AND TESTING**9**

General concepts of Food Analysis and Testing, Fundamentals of field level and laboratory sampling with reference to importance of statistical tools, Overview of basic/classical methods of food analysis, Overview of modern analytical techniques including mass spectrometry and molecular techniques, Principles of Quality assurance and Quality control with reference to food analysis and testing.

TOTAL: 45 PERIODS**COURSE OUTCOME**

- CO1 To make the student understand the various testing procedures
- CO2 To facilitate the student in understanding the anti-nutritional factors present in foods
- CO3 To make the student to understand about the microbial food safety
- CO4 To make the student to understand about the hard controls at all stages of food manufacturing
- CO5 To facilitate them in understanding the overall management of food laboratory

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick

UNIT I INTRODUCTION**9**

Fundamentals of Food Quality Assurance and Quality Control, Quality Assurance in Food Industry Validation and Verification, Quality Control and testing procedures, Documentation, Good Documentation Practices, SOPs & Protocols, Establishing Quality Control Checks Inspection & Audits.

UNIT II EMERGING GUIDELINES**9**

Role of Good Manufacturing Practices and their regulations in Quality Assurance and Quality Control, Total Quality Management in Food Industry, Quality Assurance- A risk-based approach (Possible problems & Fixes), Quality Certifications, Govt. Regulations, ISO, FSSAI & FDA Guidelines, Emerging trends in quality related aspects of food industry, Quality Systems in major segments of food industries, Laboratory demonstration, practicals and instrument handling

UNIT III ANALYSIS AND VALIDATION**9**

Introduction to Food GMPs, cGMPs (US FDA & WHO), HVAC Systems, Food HVAC Rules and Design, Validation of HVAC Systems, HVAC Audit and Inspection, WIP, CIP, Sanitation and Hygiene Practices and In-Process, Good Laboratory Practices (GLP), Physical & Chemical analysis of food, Molecular and Elemental Analysis of Food, Microbial Analysis of Food.

UNIT IV REQUIREMENTS FOR FOOD TESTING LAB**9**

Guidelines for Sample preparation, Instrument operation and Interpretation of results, laboratory demonstration and requirements, Lay Out and Design of Lab, ISO requirement for food testing lab (ISO 17025), Microbiological analysis of food, Swab Analysis in-Process and Off – Line Process, FSSAI Regulations for food laboratory.

UNIT V HYGIENE**9**

Introduction of FSSAI, Recent update in FSSAI , Location, Layout & Facilities (Pre-Requisite Program), Receiving and storage, Types of cross-contamination, Pre-Production (Vegetable washing, thawing), Production (Cooking, Cooling, and Reheating), Holding, serving/catering/dining/transportation, Personal hygiene, Pest control, Cleaning and maintenance, Waste Handling, Record Keeping, Consumer Awareness.

TOTAL: 45 PERIODS**COURSE OUTCOME**

CO1 To make the student to understand about Food Safety

CO2 To make the student to understand about the quality assurance and delivery of safe to end users.

CO3 TO facilitate the student in understanding the analysis and validation procedures

CO4 To make the student understand the requirements for establishment of a food testing lab

CO5 To facilitate them in understanding the overall food safety management

TEXTBOOKS:

1. Food Safety Management: A Practical Guide for the Food Industry
2. Food Safety Hand Book - Ronald H. Schmidt, Gary E. Rodrick